IDC Performance Report
August 25 - September 21, 1996

IDC Staff - October 2, 1996

INTRODUCTION AND SUMMARY

This report summarizes the operational and scientific performance of the International Data Center (IDC) for the period August 25 through September 21, 1996. The IDC is not an operational system; rather, it is a prototype system that is still changing *since* GSETT-3. This report is an internal document for monitoring the IDC in order to identify and fix problems in a timely fashion. Text with new information content since the last report is shown in *italics*.

The primary and auxiliary seismic networks now consist of 38 and 56 stations, respectively, and the acoustic network consists of 7 hydroacoustic stations.

A total of 1644 events (59 per day) were reported in the Reviewed Event Bulletin (REB) for this period. Of these, 2% were added by analysts, 73% included auxiliary data, and 30% included hydroacoustic data. These are some of the best numbers since the start of GSETT-3 and are attributable in part to seismological and software improvements as well as less scanning by analysts due to reduced staffing since the end of the second quarter. Waveforms were scanned for two data days.

On September 19, regular seismic archiving was resumed with a reconfigured DataManager for the first time since it had been discontinued on August 5. This is the first step toward clearing one of the major problems that has been interfering with archiving since the mass store system was replaced earlier this year.

Important changes made this period in operations included installation of new detection threshold values for all 3C primary and auxiliary stations and a new version of DFX, which includes the capability to process data from large arrays, such as NORSAR. Also, several event characterization parameters were added to those already computed by the IDC, and new versions of MessageFTP, dman, and ConnMan were installed.

OPERATIONAL SUMMARY

A. Stations and Communications

The 38 stations of the primary network are shown in Figure 1 and listed in Table 1. The numbers of elements for arrays in Table 1 refer to distinct sites. At some arrays, data from more than one channel are available from a given site (e.g., horizontal components or channels with a different pass band). New stations added to a network during the period of a report are flagged and do not appear in analysis until the next report in order that they may be compared on an equal time basis with other stations.

The IDC began receiving continuous data from the NORSAR array, NAO, in Norway on September 16. This IMS station, will replace the relatively smaller, but co-located, NORES array, when acceptable data quality and availability have been established and new processing capabilities have been proven. Data continue to arrive from MOBC and VIB in the Queen Charlotte islands, while these stations are monitored as potential sites for acquisition of seismic T phases.

The auxiliary network currently consists of 6 single-component stations, 48 three-component (3-C) stations, and 2 arrays (Table 2 and Figure 2). These numbers exclude 18 stations accessed by telephone modem, which are presently not accessed by the IDC, except under special circumstances. The modem stations are flagged in Table 2. New auxiliary stations added to the network during the period of a report are flagged in Table 2 and excluded from analysis until the next report. Also indicated in Table 2 are stations excluded from active use by the IDC at the time of report production because of consistently inaccessible or unusable data. *FITZ has been absent from performance reports this year, because it was destroyed by lightning in February, 1995. Data remain unavailable at the IDC, but the station will be included in future reporting, because it is part of the IMS network.*

Table 1: Primary seismic stations

Code	Lat.	Lon.	Name	Country	Type	# of elements
ABKT	**37.93**	**58.12**	**Alibek**	**Turkmenistan**	**3C**	
ARCES	**69.53**	**25.51**	**ARCESS Array**	**Norway**	**Array**	**25**
ASAR	**-23.67**	**133.90**	**Alice Springs Array**	**Australia**	**Array**	**19**
BDFB	**-15.64**	**-48.01**	**Brasilia**	**Brazil**	**3C**	
BGCA	**5.18**	**18.42**	**Bogoin**	**Central African R**	**3C**	
BJT	*40.02*	*116.17*	*Baijiatuan*	*China*	*3C*	
BOSA	**-28.61**	**25.26**	**Boshof**	**South Africa**	**3C**	
CMAR	**18.46**	**98.94**	**Chiang Mai Array**	**Thailand**	**Array**	**18**
CPUP	**-26.33**	**-57.33**	**Villa Florida**	**Paraguay**	**3C**	
DBIC	**6.67**	**-4.86**	**Dimbroko**	**Ivory Coast**	**3C**	
ESDC	**39.68**	**-3.96**	**Sonseca Array**	**Spain**	**Array**	**19**
FINES	**61.44**	**26.08**	**FINESS Array**	**Finland**	**Array**	**16**
GERES	**48.85**	**13.70**	**GERESS Array**	**Germany**	**Array**	**25**
HFS	*60.13*	*13.70*	*Hagfors Array*	*Sweden*	*Array*	*8*
HIA	**49.27**	**119.74**	**Hailar**	**China**	**3C**	
ILAR	**64.77**	**-146.89**	**Eielson Array**	**U.S.A.**	**Array**	**21**
KBZ	**43.73**	**42.90**	**Khabaz**	**Russia**	**3C**	
KSAR	**37.44**	**127.88**	**Wonju Array**	**South Korea**	**Array**	**25**
LOR	47.27	3.86	Lormes	France	3C	
LPAZ	**-16.29**	**-68.13**	**La Paz**	**Bolivia**	**3C**	
MAW	**-67.60**	**62.87**	**Mawson**	**Antarctica**	**3C**	
MJAR	**36.54**	**138.21**	**Matsushiro Array**	**Japan**	**Array**	**7**
MNV	**38.43**	**-118.15**	**Mina**	**U.S.A.**	**3C**	
NORES	60.74	11.54	NORESS Array	Norway	Array	25
NRI	**69.01**	**88.00**	**Norilsk**	**Russia**	**3C**	
PDAR	**42.77**	**-109.56**	**Pinedale Array**	**U.S.A.**	**Array**	**13**
PDY	**59.63**	**112.70**	**Peleduy**	**Russia**	**3C**	
PLCA	**-40.73**	**-70.55**	**Paso Flores**	**Argentina**	**3C**	
SCHQ	**54.83**	**-66.83**	**Schefferville**	**Canada**	**3C**	
SPITS	*78.18*	*16.37*	*Spitsbergen Array*	*Norway*	*Array*	*9*
STKA	**-31.88**	**141.60**	**Stephens Creek**	**Australia**	**3C**	
TXAR	**29.33**	**-103.67**	**TXAR Array**	**U.S.A.**	**Array**	**9**
ULM	**50.25**	**-95.88**	**Lac du Bonnet**	**Canada**	**3C**	
VNDA	**-77.51**	**161.85**	**Vanda**	**Antarctica**	**3C**	
WOOL	-31.07	121.68	Woolibar	Australia	3C	
WRA	**-19.94**	**134.34**	**Warramunga Array**	**Australia**	**Array**	**20**
YKA	**62.49**	**-114.61**	**Yellowknife Array**	**Canada**	**Array**	**22**
ZAL	**53.62**	**84.79**	**Zalesovo**	**Russia**	**3C**	

Bold/Italicized entries indicate stations slated for the primary/auxiliary IMS network.
* New station added during the period of this report; excluded from report analysis.

Table 2: Auxiliary seismic stations

Code	Lat.	Lon.	Name	Country	Type
AAE #	9.03	38.77	Addis Ababa	Ethiopia	3C
AFI #	**-13.91**	**-171.78**	**Afiamalu**	**Western Samoa**	**3C**
ALQ	**34.94**	**-106.46**	**Albuquerque**	**U.S.A.**	**3C**
AQU #	42.35	13.41	L'Aquila	Italy	3C
ARMA	-30.42	151.63	Armidale	Australia	3C
ARU	**56.43**	**58.56**	**Arti**	**Russia**	**3C**
BBB	**52.18**	**-128.11**	**Bella Bella**	**Canada**	**3C**
BFO	48.33	8.33	Black Forest	Germany	3C
BORG	**64.75**	**-21.33**	**Borgarfjordur**	**Iceland**	**3C**
BRG **	50.87	13.94	Berggiesshuebel	Germany	3C
BUG	51.44	7.27	Bochum	Germany	3C
CLL	51.31	13.00	Collm	Germany	3C
CLZ	51.84	10.37	Clausthal	Germany	3C
CSY	-66.29	110.53	Casey Station	Antarctica	1C
CTA	**-20.09**	**146.25**	**Charters Towers**	**Australia**	**3C**
DAV #	**7.09**	**125.57**	**Davao**	**Philippines**	**3C**

Table 2: Auxiliary seismic stations *(Continued)*

Code	Lat.	Lon.	Name	Country	Type
DAVOS	**46.84**	**9.79**	**Davos**	**Switzerland**	**3C**
DLBC	**58.44**	**-130.03**	**Dease Lake**	**Canada**	**3C**
EKA	**55.33**	**-3.16**	**Eskdalemuir Array**	**U.K.**	**Array (20)**
ELK	**40.74**	**-115.24**	**Elko**	**U.S.A.**	**3C**
FITZ	**-18.10**	**125.64**	**Fitzroy Crossing**	**Australia**	**3C**
FORT	-30.78	128.06	Forrest	Australia	1C
FRB	**63.75**	**-68.55**	**Iqaluit**	**Canada**	**3C**
FUR	48.16	11.28	Fuerstenfeldbruck	Germany	3C
GRFO	49.69	11.22	Grafenberg	Germany	3C
HGN	50.76	5.93	Heimansgroeve	The Netherlands	3C
HNR #	**-9.43**	**159.95**	**Honiara**	**Solomon Islands**	**3C**
INK	**68.31**	**-133.52**	**Inuvik**	**Canada**	**3C**
ISG	24.38	124.23	Ishigaki-jima	Japan	3C
JER **	31.77	35.20	Jerusalem	Israel	3C
JTS **	**10.29**	**-84.95**	**Las Juntas de Abanga**	**Costa Rica**	**3C**
KAF	62.11	26.31	Kangasniemi Station	Finland	3C
KIEV #	50.69	29.21	Kiev	Ukraine	3C
KKJ	41.78	140.18	Kaminokuni	Japan	3C
KVAR	**43.96**	**42.70**	**Kislovodsk Array**	**Russia**	**Array (4)**
LSZ #	**-15.28**	**28.19**	**Lusaka**	**Zambia**	**3C**
MBC	**76.24**	**-119.36**	**Mould Bay**	**Canada**	**3C**
MEEK	-26.64	118.61	Meekathara	Australia	1C
MOX	50.64	11.62	Moxa	Germany	3C
MSEY **	-4.67	55.48	Mahe	Seychelles	3C
NEW	**48.26**	**-117.12**	**Newport**	**U.S.A.**	**3C**
NIL	33.65	73.25	Nilore	Pakistan	3C
NNA **	**-11.99**	**-76.84**	**Nana**	**Peru**	**3C**
NWAO #	**-32.93**	**117.23**	**Narrogin**	**Australia**	**3C**
OBN	**55.12**	**36.60**	**Obninsk**	**Russia**	**3C**
OGS	27.05	142.20	Ogasawara	Japan	3C
PAB #	39.55	-4.35	San Pablo	Spain	3C
PFO	**33.61**	**-116.45**	**Pinon Flat**	**U.S.A.**	**3C**
PMG #	**-9.41**	**147.15**	**Port Moresby**	**New Guinea**	**3C**
PSZ	47.92	19.89	Piszkes	Hungary	3C
PTGA #	**-.73**	**-59.97**	**Pitinga**	**Brazil**	**3C**
QIS	-20.56	139.61	Mt Isa	Australia	1C
RAR #	**-21.21**	**-159.77**	**Rarotonga**	**Cook Islands**	**3C**
RMQ	-26.49	148.75	Roma	Australia	1C
RPN	**-27.13**	**-109.33**	**Rapanui**	**Chile**	**3C**
SADO	**44.77**	**-79.14**	**Sadowa**	**Canada**	**3C**
SDV #	**8.88**	**-70.63**	**Santo Domingo**	**Venezuela**	**3C**
SFJ #	**67.00**	**-50.62**	**Sondre Stromfjord**	**Greenland**	**3C**
SHK	34.53	132.68	Shiraki	Japan	3C
SNZO #	-41.31	174.70	South Karori	New Zealand	3C
SUR	**-32.38**	**20.81**	**Sutherland**	**South Africa**	**3C**
TBT #	28.68	-17.91	Taburiente	Spain	3C
TKL	**35.66**	**-83.77**	**Tuckaleechee Caverns**	**U.S.A.**	**3C**
TNS	50.22	8.45	Taunus	Germany	3C
TOO	-37.57	145.49	Toolangi	Australia	3C
TSK	36.21	140.11	Tsukuba	Japan	3C
TSUM #	**-19.20**	**17.58**	**Tsumeb**	**Namibia**	**3C**
ULN	47.87	107.05	Ulaanbaatar	Mongolia	3C
VAF	63.04	22.67	Ylistaro Station	Finland	3C
VRAC	**49.31**	**16.59**	**Vranov**	**Czech Republic**	**3C**
VTS #	42.62	23.24	Vitosha	Bulgaria	3C
WARB	-26.18	126.64	Warburton	Australia	3C
WOL	51.31	-1.22	Wolverton	U.K.	3C
YOU	-34.28	148.38	Young	Australia	1C

Bold/Italicized entries indicate stations slated for the IMS auxiliary/primary network.
* New station added during the period of this report; excluded from analysis
** Not used by the IDC for some time due to consistently inaccessible or unusable data.
\# Accessed by modem dialup. Not normally used at the present time.

Acoustic stations for which the IDC is currently receiving continuous data are shown in Table 3 and Figure 3. The acoustic network currently consists of the 7 hydroacoustic stations, ASC19, 21, 26, 27, 29, PSUR, and WAKE. Since the four infrasound stations in Table 3 and Figure 3 are not yet incorporated into the standard IDC processing pipeline, they are analyzed later in this report only with respect to data availability.

Table 3: Hydroacoustic and infrasound stations

Code	Lat.	Lon.	Name	Country	Station type	# of elements
ASC19	-7.82	-14.60	Ascension Island	U.S.A.	hydroacoustic	1
ASC21	-7.99	-14.49	Ascension Island	U.S.A.	hydroacoustic	1
ASC26	-7.94	-14.62	Ascension Island	U.S.A.	hydroacoustic	1
ASC27	-7.85	-14.37	Ascension Island	U.S.A.	hydroacoustic	1
ASC29	-7.95	-14.27	Ascension Island	U.S.A.	hydroacoustic	1
LSAR *	35.87	-106.33	Los Alamos, New Mex.	U.S.A.	infrasound	4
PSUR	36.30	-122.39	Point Sur, California	U.S.A.	hydroacoustic	1
SGAR *	37.02	-113.62	St. George, Utah	U.S.A.	infrasound	4
TXAR *	29.33	-103.67	TXAR array, Texas	U.S.A.	infrasound	3
WAKE	19.27	166.62	Wake Island	U.S.A.	hydroacoustic	1
WRAI *	-19.94	134.23	Warramunga	Australia	infrasound	7

* Infrasound stations are not yet included in standard IDC processing.

The radionuclide stations from which the IDC is currently receiving and reviewing data are listed in Table 4 and Figure 4.

Table 4: Radionuclide stations

Code	Lat.	Lon.	Name	Country	Sample type *
AU001	-37.45	144.58	Melbourne	Australia	P
CA001	45.30	-75.70	Ottawa	Canada	P
CA002	49.26	-123.25	Vancouver	Canada	P
CA003	74.70	-94.90	Resolute	Canada	P
CA004	62.45	-114.48	Yellowknife	Canada	P
CA005	47.00	-53.00	St. John's	Canada	P
DE002	47.92	7.91	Schauinsland	Germany	P
FI001	60.21	25.06	Helsinki	Finland	P
KW001	29.00	48.00	Kuwait City	Kuwait	P
NZ001	-35.12	173.27	Kaitaia	New Zealand	P
NZ002	-21.25	-159.75	Rarotonga	New Zealand	P
NZ003	-42.72	170.97	Hokitika	New Zealand	P
RU001	44.00	132.00	Ussuriysk	Russia	G&P
SE001	59.00	18.00	Stockholm	Sweden	G&P
UK001	51.50	-1.50	Chilton	England	P
US001	38.00	-78.00	Charlottesville	U.S.A.	P

* P = particulate; G = Xenon gas

Figure 5 and Table 5 show the status this period of the dedicated communication link segments from the NDCs that terminate at the IDC. Uptime percentages are simple averages based on daily sampling. For rare days on which no communication link uptimes are available, such as when a problem occurs at the IDC *(e.g., August 28)*, the affected links are assumed to have been up 100% of those days. Several of the links are backed up by an Internet line, which takes over when the dedicated link goes down, but there is currently no means of accounting for this rerouting in Figure 5 and Table 5. The numbers for RUS_NDC are probably poorer than they should be, because the IDC was unable to effectively monitor this link until the telecommunications provider was changed and appropriate software modifications made at the end of March this year.

Table 5: Communication link performance since 96/01/01

Origin	Baud Rate	Uptime (kbit/sec)	Previous Avg (%)
AUS_NDC	19.2	97.0	93.1
CAN_NDC	56.0	100.0	99.5
CHN_NDC	56.0	99.4	92.7
FRA_NDC	56.0	100.0	99.3
JPN_NDC	64.0	100.0	99.9
NOR_NDC	256.0	98.8	98.6
PNT_SUR *	9.6	95.2	89.2
RUS_NDC	64.0	100.0	87.4
RUS_OME	38.4	100.0	97.0
USA_NDC	1500.0	98.5	99.3

* Link established subsequent to 96/01/01.

Primary station capability is presented in Figure 6. Station capability is normally estimated automatically once each day, *7 to 12 hours* after the end of the day (UTC) and therefore does not include data that arrive at the IDC after that. For arrays, the station capability is based on the ratio of theoretical signal gain with channels actually available to the signal gain expected if all channels were available. For 3-component stations, full capability indicates that all 3 channels were operational; partial means the vertical and one horizontal; and low, one channel. Each section of a stacked bar indicates the percentage of the reporting period for which the respective capability was met. Because the plotted values are computed at the tail end of the data stream (i.e, at the IDC), they represent the culmination of all factors affecting data flow from the station.

Problems with primary station capability are frequently caused by failures of communications infrastructure. Other common causes include problems with site hardware, power supply, or data transmission software. No data are being sent to the IDC from ABKT, KBZ, LPAZ, NRI, and VNDA because of station or communications related problems. Misalignment of a satellite dish prevented reception from STKA from September 4 through 16. The upcoming replacement of NORES with NAO will render obsolete the long-term problems with several sites at NORES. The TXIAR infrasound array experiences occasional drops to partial capability because of equipment problems at one site. LSAR and SGAR are often non-capable, because data for these stations is usually sent to the IDC one day behind real time.

Figure 7 shows the percentage of days during which auxiliary data were available to the IDC as determined by an automatic polling process that interrogates the stations once each day. The polling process continues to query a station that has been excluded from use in event formation as a means of determining when/if the station can be returned to active status. Data availability has been historically unreliable for JER, JTS, and NNA. *BRG was taken down since August 19 for electrical installations. MSEY has been dropped from use and polling, until questions regarding access are resolved. PSZ came back on line September 10, after repairs were completed for lightning damage. Access to ULN, which gets many requests from the IDC, has improved significantly since it was switched from phone to Telnet access several weeks ago. Of these stations, JTS and NNA are slated for the IMS network. A bug in the TKL AutoDRM causes polling results at the IDC to complete as failed, but data are generally available from the station for event processing.*

Figure 8 shows the percentages of requests for auxiliary data that completed successfully for actual events in the AEL. *ISG is down for repairs on a timing problem. The IDC did not begin using PFO (which was dropped from the primary network last period) as an IMS auxiliary station until September 6, when it was resolved from where the IDC would request the data.*

Data availability from the radionuclide network is reflected by the number of samples received at the IDC versus the expected frequency of receipt (Table 6). The timeliness of notification from the IDC to station personnel regarding unreceived data is, by convention, about the same as the expected frequency of receipt. *RU001 and US001 had the most significant problems this period. RU001 was off line until September 20, and detector problems accounted for the missed spectra from US001. At CA002, one sample was collected for four days, while a communications problem was fixed at the site. Two samples were not received from AU001 because of a long decay on one and another that was collected twice as long as normal. No sample was received from NZ003 for September 4.*

Rapid availability of data is critical to the monitoring mission of the prototype IDC System. Figure 9 shows estimates of the timeliness of receipt of primary data at the IDC. These are based on comparison of the end times and load dates of "interval" records in the IDC database and may overestimate the actual time delay before which data were available. Nevertheless, Figure 9 indicates which stations normally contribute data in time to be used for preparing the automatic event lists: AEL (1 hour), ABEL (4 hours) and DEL (10 hours). The DEL is used by analysts as a basis for REB formation. *Most of the transmission delays shown in Figure 9 are due to the problems mentioned in the discussion on primary station capability. Transmission delays from HIA result from poor phone line service from the site.*

Other problems with stations and communications are shown in Table 7.

Code	Sample type *	Expected frequency	Samples received
AU001	P	5x week	18
CA001	P	weekly	4
CA002	P	daily	25
CA003	P	biweekly	2
CA004	P	biweekly	2
CA005	P	monthly	1
DE002	P	weekly	5
FI001	P	weekly	4
KW001	P	daily	28
NZ001	P	weekly	4
NZ002	P	weekly	4
NZ003	P	weekly	3
RU001	P	2x week	2
RU001	G	2x week	0
SE001	P	weekly	4
SE001	G	2x week	7
UK001	P	weekly	4
US001	P	daily	20

Table 6: Numbers of radionuclide spectra reviewed and released

* P = particulate; G = Xenon gas

Table 7: Technical problems affecting station data

Station	From	To	Problem
AAE	96/06/08		Timing error
ABKT	96/08/25	96/08/28	Stn not attempting to connect to IDC
ABKT	96/09/07		Data not available
ALQ, ELK, NEW	96/08/23	96/08/26	Data not available
ARCES	96/05/31		Noisy channel(s)
ARU	96/09/15	96/09/18	Data not available
ASAR	96/09/06	96/09/12	Variable data availability
ASAR, STKA, WRA	96/08/27	96/09/09	Data not available
ASCH stations	96/09/18		Calibration; also, cable probl cause outages
AUS auxil. netw.	96/09/06	96/09/08	Communications failure; data not available
All AUS auxil stns	96/09/02	96/09/06	AutoDRM errors
All US NDC stns	96/09/14	96/09/14	Scheduled power outage
BDFB	96/08/30	96/09/09	Communications failure
BDFB	96/09/19		Station down
BGCA	96/08/27	96/09/08	Data not available
BJT	96/09/04	96/09/12	Data not available
BORG	96/08/26	96/09/02	Data not available
BOSA	96/07/22	96/08/28	Station down
BRG	96/08/19		Station down for maintenance
CAN auxil stns	96/08/19		Data inaccessible some days
CMAR	96/09/07	96/09/10	Data not available
CMAR	96/09/18	96/09/18	Data not available
CPUP	96/09/21		Data not available
CPUP	96/09/21		Data not available
CSY	96/05/19		Timing error
DAV	96/04/09		Long-term problem with phone lines
DBIC	96/09/15		Data not available; stn not connecting
FINES	96/09/08	96/09/14	Array element FIB1 down
HIA	96/04/10		Data not available
HIA	96/08/19		Corrupt format frames; data rejected by IDC
IRIS IDA stns	96/07/31	96/08/28	AutoDRM error
ISG	96/08/13		Timing error
JER	96/06/23		Data not available; time-stamp error
JPN auxil stns	96/09/13		AutoDRM problem
JTS	96/05/16		Data requests failing
KBZ	96/06/25		Data not available
KIEV	96/04/20		Long-term problem with phone lines
KIEV	96/05/17		Data requests failing
KVAR	96/04/22		Anomalous amplitudes
KVAR	96/08/15		Variable data availability
LPAZ	96/08/30		Station down

Table 7: Technical problems affecting station data *(Continued)*

Station	From	To	Problem
LSZ	95/11/22		Long-term problem with phone lines
MAW	96/09/05	96/09/12	Data not available
MAW	96/09/11	96/09/12	Timing errors and frequent reconnects
MNV	96/08/16		low amplitudes
MNV	96/08/27	96/08/29	Data not available
MNV	96/08/30		Noisy channel(s)
MSEY	96/05/10		Data not available
NAO	96/09/11		Data not available; array not connecting
NNA	96/07/05		Data not available
NORES	96/05/14		Array partially mission capable
NORES	96/09/05		Intermittent timing error
NRI	96/08/26		Stn not attempting to connect to IDC
OGS,TSK,KKJ,SHK	96/09/21		AutoDRM shutdown during power maintenance
PDAR	96/06/16	96/09/05	Data not available; array partially capable
PDAR	96/08/16	96/09/13	low LR amplitudes
PDY	96/09/07	96/09/09	Data not available
PDY	96/09/11	96/09/17	Software and comm problems; data not avail.
PFO	96/09/08	96/09/09	Data not available
PLCA	96/08/17	96/08/30	Station down
PLCA	96/09/07	96/09/10	Unreliable data availability
PSZ	96/08/09	96/09/14	Data request failing
PTGA	96/05/06		Connection cannot be completed
QIS	95/12/06		Noisy channel(s)
RAR	96/06/08		Data not avail.; comm protocol error
RPN	96/07/18	96/09/05	Data not available
SDV	95/09/13		Long-term problem with phone lines
SHK	96/09/08	96/09/11	Data not available
SPITS	96/08/16		high LR amplitudes
STKA	96/08/27	96/09/17	Communications failures
SUR	96/08/22	96/08/26	Data not available
SUR	96/09/07	96/09/10	Internet communications failure
TBT	96/06/08		Noisy vertical component
TKL	95/12/28		AutoDRM problem; data incomplete
TKL	96/09/18	96/09/20	Data not available
TX01 (seismic)	96/07/09	96/09/08	Unreliable data availability
TXAR infrasonic	96/07/09		Array partially or non capable; TXI01 outages
ULN	96/08/25	96/08/27	Noisy data during site repairs
VNDA	96/03/26		Station down
VTS	96/06/03		Station modem not answering
WAKE	96/09/03	96/09/06	Data not available
WAKE	96/09/12		Communications failure
WARB	96/09/04	96/09/10	Data not available
WOL	96/08/23	96/08/27	Data not available
WOOL	96/09/06	96/09/08	Data not available
WRA	96/03/24	96/09/05	Noisy channels

B. IDC Facility and Logistical Factors

Facility operation was normal.

C. IDC Hardware Infrastructure

The mass storage hardware at the IDC has had serious malfunctions, from the time it was installed in the first week of May. Problems began to surface in June in the form of system hangs when retrieving certain files. During that month, the software vendor made several unsuccessful attempts to remedy the problem with various firmware and software installations. In August, the vendor consulted a third party, which eventually identified the problem as a mis-configuration of DataManager, a software layer that provides hierarchical file management. On August 5, DataManager was turned off, and archiving was diverted to a new partition, which writes directly to DLT. This mechanism is inherently inefficient and necessitated limiting access to the data. On September 19, regular seismic archiving was resumed with a reconfigured DataManager. Meanwhile, the vendor has been restoring tapes for the IDC from the time of the original installation of the mass store system in May.

There were no other major setbacks to operations this period from hardware related failures. A minor interruption to operations occurred on September 10 at about 24:00 UT, when a power failure took both databases down for an hour and a half and forced some other computers to reboot.

D. IDC Software Infrastructure

Figure 10 shows the load on the operational database during this period. Daily peaks in connections coincide with heavy database usage during business hours at the IDC. *The drop in database activity on September 10/11 resulted from the power break described in "Hardware Infrastructure".*

The mass storage device continues to be unreliable. The host machine, bigbyte, *fails under all operating conditions and tends to cause AutoDRM to hang. These problems have affected the system since its installation.*

A few machines in or affecting operations are not expected to join the others in the upgrade to Solaris 2.5 in the near future. *Ndegei* and *mimer* have been around so long that they are too enmeshed in old file structures to be readily changed. *Mars* runs software that is not yet compatible with 2.5.

E. IDC Seismic Data Processing

Data Import and Export

Table 8 shows the volume of waveform data received at the IDC during this period. GSETT-3 data not in the mass stores are stored offline. Event bulletins are available on the operational database for up to about 6 weeks. Other items may be purged earlier (e.g., wfdisc tables, ˜1 week) in order to maintain efficient table sizes for operations.

Table 8: Volume of data received at the IDC by station network

Network	Current (MB/day)	Previous Average (MB/day)
Primary	2834.5	2640.4
Auxiliary	104.6	100.9
Hydroacoustic	247.6	131.4
Infrasound	69.0	32.8

Table 9 shows the numbers of bulletins and waveforms exported from the IDC by standard subscriptions during the current period. *Some of the automatic processes which generate the daily system reports (primary and acoustic capability and communication link status) failed on several days this period, resulting in distribution delays of several hours to a day. A solution that may fix many of the failures has been proposed, and it is hoped that a repair can be implemented next period.*

Table 9: IDC subscription data exports

Product	Schedule	Category	Subscriptions	
			Complete	Constrained
AEL	Daily	Bulletin	7	4
ABEL	Daily	Bulletin	5	3
REB	Daily	Bulletin	45	18
data	Continuous	Waveforms	30	
Station Status	Daily	System Report	42	
Channel Status	Daily	System Report	4	
Comm Status	Daily	System Report	32	
Extended Comm Status	Daily	System Report	2	

The IDC currently forwards continuous waveform data from primary stations to the France, Russia, and United States NDCs. The progress of this system throughout the report period is depicted in Figure 11, *which has been improved from previous reports. Each shaded brick in Figure 11 now represents the ratio of the volume exported from the IDC for the given data stream and day to the volume received at the IDC the same day. A brick with diagonals indicates a greater volume forwarded than received on that date during catch-up from delays either in the forwarding system or somewhere upstream. Unlike previously, the absence of bricks from a stream now indicates that no data were received at the IDC during that day. This new representation became possible recently, when IDC-developed software was installed to track data entering and exiting the diskloops at regular intervals.*

The diskloop server (DLS), which receives the data and the heap server (HPS), which buffers and forwards it, are also shown in Figure 11. Grouping of data streams is by destination, DLS, and HPS, *in that order. It is hoped that this format will facilitate correlation between host machines and problems with the streams they handle. For example, a persistent problem, one lasting the major portion of a day or more, with one of these machines should appear as stacks of dark bricks corresponding to all streams that pass through that machine during the affected day(s).*

There is still some limitation to the ability of Figure 11 to show the effectiveness of data forwarding from the IDC. Because of the varying amounts of compression represented in the volumes used for the figure, a day of 100% forwarding (white box) does not necessarily indicate 100% of the data for that data day. It means only that the same amount of data received during that date was also forwarded the same day.

Some of the dark columns in Figure 11 can be explained by problems with the forwarding system at the IDC on those days and with DLMan. On September 5, it was discovered that AlphaForward was not sending anything, even though AlphaDLHeap was heaping data. This explains some of the black bricks for the previous day. Another problem on these two days resulted from a bug in DLMan, which writes incoming data to the diskloops. The bug causes it to consume excessive amounts of memory on the laufey *DLS on some days because of difficulty handling the newly added NAO data stream. The drop in forwarding success for all streams on September 11 occurred because of another DLMan bug which prevents it from automatically re-establishing a lost alarm loop timer. The alarm loop monitors diskloop connections to time them out when no data has been received for some time, and it also keeps a certain database table updated. The power break noted in* "*Hardware Infrastructure*" *at about 24:00 on September 10 caused all the DLMan's to lose their alarm loop timers. This eventually blocked data flow through the pipeline and interferred with forwarding. Sometimes when one or more streams get broken, the IDC forwarding software fails to backfill large segments of data. An effort was made to address this problem (See* "*System Changes to the Prototype IDC*"*).*

Problems occurred with production of the daily system reports on a few occasions. Delays were generally no more than several hours, with the exception of one case lasting about a day,

Volumes of data exported from the IDC to various countries by AutoDRM are given in Table 10.

Table 10: IDC data export by AutoDRM

Country	GSE2.0 Messages	Message Volume (Mbyte)
Canada	9	3.931
Chile	1	0.000
China	8	18.743
France	11	21.479
Germany	15	7.147
Italy	9	0.283
Japan	3	17.353
Norway	11	5.515
Russian Federation	18	5.328
Spain	2	0.749
United Kingdom	1	0.007
United States	1588	32.508
Total	1676	113.044

Automatic Processing

The IDC strives to complete the AEL and ABEL within 1 hour and 4 hours, respectively, of event origin time. Actual completion times of 90% of the events for each event list are plotted against target times in Figure 12, and brief explanations for event list delays are given in Table 11. *Except for one day, September 20, there were no significant delays in automatic processing. The cause of the problem on September 20 is uncertain, because it occurred after hours, but is suspected of having been a hung CommAgent.*

Table 11: Automatic processing: Data day outcomes

Date	Jdate	Problems	Outcome
96/08/25	1996238	PMshell failed to start for StaProB	
96/08/26	1996239	WM-GetSeg failed to start	
96/08/27	1996240	GAconflict crashed	
96/08/28	1996241	CommAgent Retrieve crashed	
96/08/29	1996242		
96/08/30	1996243		
96/08/31	1996244		
96/09/01	1996245		
96/09/02	1996246		
96/09/03	1996247		
96/09/04	1996248		
96/09/05	1996249		
96/09/06	1996250		
96/09/07	1996251	*laufey* hung	
96/09/08	1996252		
96/09/09	1996253	*mimer* disk failure	
96/09/10	1996254	1.5 hour outage of operational database due to power break; *seismo* failure	
96/09/11	1996255		
96/09/12	1996256		
96/09/13	1996257	*mimer* down for disk replacement	
96/09/14	1996258		
96/09/15	1996259		
96/09/16	1996260	CommAgent-Pipeline crashed	
96/09/17	1996261	*fenris* failure	
96/09/18	1996262		
96/09/19	1996263	*gerd* failure	
96/09/20	1996264	Early morning pipeline failure; suspect hung CommAgent	delayed AEL and ABEL
96/09/21	1996265		

Analyst Review

Figure 12 shows the time that events were saved in the REB database account relative to the event origin time. The IDC attempts to complete the Reviewed Event Bulletin (REB) within 2 to 4 days following the end of each data day, which can range from 48 to 96 hours after the event origin time.

Completion times for REBs ranged from 1.8 to 4.9 days, after the ends of datadays and averaged 3.1 days. Scanning was apparently responsible for the longest delay on August 29. Sequences of events in the Taiwan and Solomon Islands areas contributed to the delay for September 6. The longest completion times are generally associated with the REBs for Thursday through Saturday or Sunday, because no analysis is done on weekends.

Scanning was done for two data days this period, August 29 and September 5. Scanning is the process whereby analysts search for and form events missed by the automatic system, so the REB is more complete when this procedure is used.

PIDC 4.0.14, installed September 5, fixed problem 1, paragraph 2, section "Analyst Review" of the last report, in which ARS had been crashing when the user would delete a station magnitude, resave the event, and select a new event. The release also contains a fix to another problem developers discovered in which ARS would crash whenever the magnitude arrivals GUI was displayed and a new event was selected.

F. System Changes to the Prototype IDC

A number of changes were made in IDC operations. The new detection threshold values for 3C stations, approved by the IDC Configuration Control Board (CCB) last period, were installed August 25.

The suite of event characterization parameters computed at the IDC was augmented on August 26 to include spectral variance, cepstral quefrencies and peak amplitudes, and complexity in accordance with an August 1 CCB proposal.

New versions of DFX were installed on August 27 and September 13, PIDC 4.0.11-13 and 15. These provide capability for processing data from large arrays, such as NAO, along with threshold monitoring, several bug fixes, and improved error checking for cases in which sample rates differ between components of a station.

MessageFTP 0.3, installed September 18, fixes a minor bug that was preventing successful auxiliary waveform retrievals by ftp. It also provides more descriptive problem reporting and supports retrieval via non-anonymous ftp.

An effort was made to improve backfilling in forwarding of all stations, beginning September 20, by increasing a parameter in AlphaDLHeap that constrains the minimum number of segments of time-sequential data that must be exported in a single batch.

Some minor improvements to user interface and problem logging were made this period for dman and ConnMan.

G. Principal Operational Problems

The principal problems currently affecting the quality and reliability of operations at the IDC are:

1. irregular data availability from some primary stations
2. reduced analyst staff
3. problems related to ISIS (interprocess communication software)

SEISMOLOGICAL SUMMARY

A. Station Processing

Primary Station Performance

Figure 13 shows the phase detection rate for primary stations, and Figure 14 shows phases detected but unassociated. Noise represents a significant percentage of the detections from most stations. *A high frequency noise source, possibly near the site, has been causing many false detections on MNV data.*

Auxiliary Station Performance

Phase detection performance at the IDC for the auxiliary stations is presented in Figures 15 and 16. The previous daily average for MBC is excluded from Figure 15, because it is much larger than for the other auxiliary stations. This is because it was used as a primary station until recently. The high rate of unassociated P detections for QIS may be caused by unusually high activity of rock crushers, which are known to operate in mines near the station.

Supplementary Data Availability

Table 12 summarizes supplementary data that have been received by the IDC from the 23 contributing countries and parsed into the IDC database since the start of GSETT-3. *Sweden began contributing data this period from the SWE_NDC. They are submitting seperately from Norway and Finland, who are submitting through the FIN_NDC.* The IDC has had trouble with the process that parses supplementary data. Errors frequently occur when processing newly reported events that replace previously reported events. The IDC has arranged with some countries to delete the previous solutions in advance in order to avoid this problem.

Table 12: Summary of supplementary data in the IDC database as of 96/09/23

Source	First	Last	Total # events	min ML	max ML
AUS_NDC	95/01/01	96/03/30	160	2.2	4.9
BGR_NDC	95/01/01	95/04/24	89	2.4 *	4.4 *
CAN_NDC	94/08/01	96/07/25	857	1.4	5.5
CHE_NDC	94/01/17	96/08/24	55	2.5	4.6
CHN_NDC	95/01/01	96/04/30	5500	2.7	7.1
DEU_NDC	95/11/01	96/06/30	948	1.5	5.9
DMK_NDC	95/05/30	95/11/30	3	3.0	4.1
ESP_NDC	93/05/01	96/06/30	2172	1.8	5.0
FIN_NDC	94/12/08	96/02/29	1594	1.1	3.9
FRA_NDC	93/06/01	96/08/27	1149	1.9	5.6
GBR_NDC	95/01/01	96/09/20	42	2.5	5.5
HUN_NDC	95/01/23	95/10/09	13	1.6	5.0
ISR_NDC	95/01/02	95/10/22	37	2.4	3.5
ITA_NDC	93/11/05	96/08/30	1170	2.0	6.2
JPN_NDC	94/01/31	96/09/16	20012	2.1	7.9
NZL_NDC	94/07/01	95/02/28	6242	3.0	6.8
PER_NDC	96/05/29	96/08/31	170	3.2 *	5.4 *
POL_NDC	95/01/01	95/12/31	461	2.0	3.9
ROM_NDC	95/01/02	96/09/20	327	2.5 *	5.1 *
RSA_NDC	95/01/02	96/07/31	1005	1.8	4.7
RUS_NDC	95/01/01	96/08/31	3537	2.7 *	5.1 *
SWE_NDC	95/01/11	96/03/21	92	N/A	N/A
USA_NDC	95/01/01	96/09/01	4088	2.1	6.0

* Duration magnitudes are shown for BGR, PER, and ROM NDCs; body-wave magnitudes for RUS_NDC.

Automatic Signal Processing

Changes to phase timing, identification and association with events take up much of an analyst's time, and an important objective of automatic processing is to minimize the number of changes required. Table 13 shows some of the changes to arrivals during the analyst review as reported in the Reviewed Event Bulletin (REB). The percentages of all phase changes are relative to the total number of defining phases in the REB, except for retimed phases, which are relative to the number of time-defining phases. Numbers for the current quarter do not include the current period.

The number of phases, as a percentage of the defining phases in the REB, added by analysts this period was 35% less than it has been so far for the third quarter. Given the lack of scanning since late June, it is difficult to say how much of this number reflects recent improvements in the detection system (e.g., from the new DFX, new detection thresholds for 3C stations, etc.). The percentage of renamed phases increased by 56% this period from the third quarter value, which probably resulted from the overall increase in detection rates with the new detection thresholds for 3C stations.

Table 13: Changes of phases during the analyst review

Type of Change	Current		1995 Q4		1996 Q1		1996 Q2		1996 Q3	
	# of Phases	% of Def	#	%	#	%	#	%	#	%
Unmodified	6587	28.0	7033	9.8	16854	19.3	24230	26.4	11889	28.6
Retimed	7660	32.6	37015	51.6	32925	37.8	30758	33.6	12431	29.9
Added	4686	19.9	24163	33.7	28837	33.1	26740	29.2	12862	30.9
Associated	11694	49.7	43774	61.0	53305	61.2	49249	53.7	21822	52.5
Renamed	8697	37.0	17626	24.6	22481	25.8	23319	25.4	9840	23.7
Disassociated	N/A	N/A	95664	133.3	96743	111.0	N/A	N/A	44359	106.7

B. Event Bulletins

Automatic Event Processing

Table 14 shows the numbers of events in automatic lists and the reviewed bulletin. Percentages are normalized to the number of events in the REB. The event definition criteria are more restrictive for the REB than for the automatic event lists. *A total of 1644 events (59 per day) were in the Reviewed Event Bulletin (REB) for this period. Of these, 2% were added by analysts and 73% included auxiliary data. These are the best numbers recorded so far on a quarterly basis for these categories since the start of GSETT-3. They reflect improvements in the GSETT-3 system, such as in detection* *processing (DFX) and association (GA) software at the IDC, instrument calibrations and detection thresholds for primary stations, and improved primary network coverage in certain parts of the world, such as along the west Pacific rim and in South America. However, the lack of scanning for missed events by analysts has also contributed to the decline in numbers of analyst-added events during the third quarter of 1996. Use of hydroacoustic data continued to increase this period since it was first introduced into processing earlier this quarter.*

The problem with multiple associations of arrivals described in this section of the last report was reported by developers as having been repaired in one of the patches of PIDC release 4.0.0-10, installed August 19. The installation had not been announced immediately and was, therefore, unknown to the authors until after publication of that report.

Table 14: Numbers of events in the various bulletins

Category	Current		1995 Q4		1996 Q1		1996 Q2		1996 Q3	
	# Events	% REB	#	%	#	%	#	%	#	%
AEL (all)	3787	230.4	9638	172.7	10516	151.1	12227	186.0	5708	188.5
AEL (>= 3 stations)	2722	165.6	7768	139.2	7955	114.3	8258	125.7	3751	123.9
ABEL (all)	3198	194.5	11121	199.3	10938	157.1	12007	182.7	5017	165.7
ABEL (>= 3 stations)	2625	159.7	9618	172.3	8787	126.2	8733	132.9	3806	125.7
DEL (all)	3298	200.6	11258	201.7	10876	156.2	12058	183.5	5147	170.0
DEL (>= 3 stations)	2821	171.6	10150	181.9	9340	134.2	9596	146.0	4143	136.8
REB (all; >= 3 stations)	1644	100.0	5581	100.0	6961	100.0	6572	100.0	3028	100.0
With Auxiliary Data	1207	73.4	3407	61.0	4127	59.3	4746	72.2	1939	64.0
With Hydro Data	493	30.0	0	0.0	0	0.0	819	12.5	697	23.0
With Seismic T	0	0.0	3	0.0	1	0.0	1	0.0	0	0.0
Added	40	2.4	1373	24.6	1997	28.7	864	13.1	144	4.8
Rejected	1339	81.4	6107	109.4	4893	70.3	5017	76.3	1739	57.4
Unmodified	1	0.1	0	0.0	0	0.0	0	0.0	1	0.0
Split Repaired	252	15.3	960	17.2	956	13.7	1063	16.2	332	11.0

Table 15 shows the changes of epicenters between the automatic DEL and the Reviewed Event Bulletin. The greatest number of changes are typically for those events with the nearest station more than 2000 km distant and involve changes of more than 50 km.

Table 15: Changes of hypocenters between the DEL and REB

Change	Nearest	Current		1995 Q4		1996 Q1		1996 Q2		1996 Q3	
(km)	station (km)	# Events	% REB	#	%	#	%	#	%	#	%
Epicenter: < 10	< 200	4	0.2	8	0.2	20	0.3	26	0.4	8	0.3
Epicenter: 10-50	< 200	11	0.7	30	0.5	42	0.6	60	0.9	34	1.1
Epicenter: > 50	< 200	2	0.1	8	0.1	14	0.2	18	0.3	12	0.4
Epicenter: < 10	200-2000	66	4.0	135	2.4	155	2.2	189	2.9	119	3.9
Epicenter: 10-50	200-2000	207	12.6	405	7.3	477	6.9	550	8.4	333	11.0
Epicenter: > 50	200-2000	191	11.6	597	10.7	529	7.6	783	11.9	356	11.8
Epicenter: < 10	> 2000	72	4.4	143	2.6	179	2.6	251	3.8	148	4.9
Epicenter: 10-50	> 2000	285	17.3	482	8.6	707	10.2	828	12.6	571	18.9
Epicenter: > 50	> 2000	765	46.5	2400	43.0	2842	40.8	3002	45.7	1303	43.0
Depth	< 200	6	0.4	10	0.2	28	0.4	44	0.7	19	0.6
Depth	200-2000	285	17.3	598	10.7	682	9.8	912	13.9	526	17.4
Depth	> 2000	716	43.5	2419	43.3	2814	40.4	2755	41.9	1269	41.9

Distribution of Epicenters

Figure 17 shows the global distribution of epicenters in the DEL for the current period with and without the constraint of at least 6 defining phases per event, and Figure 18 shows the analogous maps for the REB. The epicenters outline the most active seismic regions. Events in the Fiji and Tonga Islands regions typically have the largest estimated uncertainties. Additional detail is provided in regional maps for the western Pacific, Europe, and western North and Central America (Figures 19 through 21).

Two days of this period were characterized by unusually large numbers of events. Many of the 113 REB events on September 6 were associated with a moderate sequence in a region just south of Taiwan that began with a m_b 5.5 event at 23:42:13 (REB) the previous night. Another more prominent sequence in the Mindanao region of the Philippines dominated the whole day of September 20 and was *characterized by 3 m_b >= 5.5 events early in the day. A total of 131 events appeared in the REB for that day, the most for any single day of the period.*

Network Capability

This section discusses the theoretical detection capability of the GSETT-3 Primary network for the *previous period, July 28 through August 24.* and considers events that may have been missed by the IDC. Because of the uneven distribution of the primary stations, the network capability varies strongly world wide. Thus, the performance of the system should be evaluated against the predicted capability. Figure 22 shows the predicted capability based on preliminary noise estimates of primary stations. The contours are adjusted by a constant factor to account for availability of data from each primary station.

The Quick Epicentral Determination (QED) of the U.S. Geological Survey (USGS) was the only global reference bulletin available at the time this report was prepared. The QED contains events determined with data from a variety of sources, including regional networks.

Figure 22 compares the REB to the QED based on the expected performance of the GSETT-3 primary network. *There were no events reported in the QED for last period with a > 90% probability of detection by the GSETT-3 network that did not also appear in the REB (Table 16).* It should be noted that the preliminary noise estimates that have been used to produce the network simulations are not very accurate, and improved noise estimates may change these results.

Table 16: Events in other bulletins but not in the REB
96/07/28 - 96/8/24

Date	Time	Latitude	Longitude	Depth (km)	m_b	Bulletin
No missed events.						

Depth Estimates

Figure 23 shows the distribution of focal depths in the REB that were unconstrained (free), constrained by ARS, constrained by the analyst or constrained using depth phases.

Figure 24 compares the IDC depth solutions that were unconstrained with QED (USGS) depths, both constrained and unconstrained. The largest discrepancies in focal depths between the bulletins tends to be among those events in the QED with depths constrained by geophysicists and those in the REB with unconstrained focal depths.

Event Definition

Distributions of the numbers of defining phases and stations used for event formation are shown in Figure 25.

Magnitude Estimates and Distributions

Table 17 summarizes the magnitudes calculated for the REB. The right-most column shows the number of events on a yearly basis, regardless of magnitude type. The last row gives averages since January 1, 1996. Body-wave magnitudes were unavailable for some events that did not have amplitudes calculated during automatic processing.

Table 17. Summary of magnitudes reported in the REB

Report period	m_b		ML		Ms		Total
	N/period	% of REB	N/period	% of REB	N/period	% of REB	N/year
Current reporting period	1492	90.8	607	36.9	165	10.0	21445
Last period	1419	90.8	507	32.5	154	9.9	20376
Average since 96/1/1	1756	89.7	736	37.6	164	8.4	25522

Figure 26 shows the recurrence rate distributions of body-wave magnitudes, m_b, and local magnitude, ML, from the current and previous periods for the global data set as well as m_b for four selected regions. Deviation at smaller magnitudes from an approximately linear trend is a rough indicator of the detection threshold for a given region. Cumulative distributions of m_b for the global data set are tabulated in Table 18.

Table 18: Cumulative m_b distribution

m_b	Current period		Last period		Total since 96/1/1	
	number	number/year	number	number/year	number	number/year
<3.0	1492	19463	1419	18511	14864	22907
3.0	1478	19281	1393	18172	14614	22522
3.1	1464	19098	1376	17950	14429	22237
3.2	1442	18811	1349	17598	14151	21809
3.3	1414	18446	1316	17167	13739	21174
3.4	1373	17911	1260	16437	13177	20308
3.5	1307	17050	1181	15406	12386	19089
3.6	1213	15824	1069	13945	11312	17433
3.7	1077	14049	958	12497	10010	15427
3.8	946	12341	818	10671	8523	13135
3.9	813	10606	692	9027	7015	10811
4.0	665	8675	551	7188	5559	8567
4.1	546	7123	438	5714	4282	6599
4.2	425	5544	334	4357	3183	4905
4.3	323	4214	251	3274	2333	3595
4.4	247	3222	178	2322	1639	2526
4.5	179	2335	139	1813	1150	1772
4.6	129	1683	97	1265	783	1207
4.7	88	1148	71	926	558	860
4.8	57	744	45	587	400	616
4.9	43	561	33	430	302	465
5.0	37	483	28	365	233	359
5.1	30	391	17	222	155	239
5.2	15	196	13	170	109	168
5.3	10	130	7	91	70	108
5.4	10	130	5	65	55	85
5.5	7	91	1	13	33	51
5.6	3	39	0	0	19	29
5.7	1	13	0	0	10	15
5.8	0	0	0	0	6	9
5.9	0	0	0	0	1	2
6.0	0	0	0	0	1	2
6.1	0	0	0	0	1	2
6.2	0	0	0	0	1	2

The top two plots in Figure 27 compare the m_b and Ms values from the IDC with their counterparts from the QED of the National Earthquake Information Center of the U.S. Geological Survey. The IDC m_b magnitudes are normally about 0.3 units smaller than the QED values due to several factors. First, amplitudes are calculated in a pass band of 0.8 - 4.5 Hz, which is higher than the corner frequency for larger events. Second, the IDC assigns more events to surface-focus than the NEIC, which results in different depth corrections. Third, the IDC uses amplitudes from array beams for many events, which assumes perfect signal coherence across the array.

The lower two plots in Figure 27 compare ML and Ms values with m_b values, where all numbers are taken from the REB. Comparison of Ms with m_b shows a tendency for Ms < m_b for smaller events and the opposite for larger events. This is a normal relationship, because smaller sources have more of their energy in the pass-band used for m_b measurements. For larger events, body-wave magnitudes saturate, and, in large crustal events, surface waves will tend to dominate the wavetrain.

Table 19 shows the scatter in station magnitudes. Factors contributing to the deviations in Table 19 include errors in instrument calibration; lack of path, station and depth corrections; and uncorrectable seismological variations (directivity, focal mechanism, etc.). For many events, IDC magnitudes are poorly constrained due to lack of amplitude estimates caused by such factors as undetected LR phases, lack of amplitudes for analyst-added phases, etc.

Table 19: Scatter in station magnitudes

Magnitude	# of observations	σ (magnitude units)	% outside $2 \cdot \sigma$
ML	527	0.33	4.4
m_b	6257	0.35	6.0

Use of Stations in Bulletin Production

Differences in the geographical distributions of seismic events and of stations of the GSETT-3 network contribute to variations among the stations in their use in event solutions. The effectiveness of processing at the IDC and operational factors, such as data availability, also contribute to variation among stations. Figures 28 and 29 show the frequency of use of data from the primary and auxiliary stations, respectively, for this reporting period. Bars show the percentages of events at local, regional, and teleseismic distances for which each station contributed detected phases associated with the REB event solutions, and the numbers above the bars show the number of events within the respective distance range. The arrays tend to have the highest usage percentage-wise for teleseismic events.

C. Principal Seismological Problems

1. poor automatic phase identification for some stations
2. large scatter in magnitude estimates

CHANGES IN PERFORMANCE WITH TIME

Changes in the numbers of stations, NDCs providing supplementary data, and the results of station processing during GSETT-3 are shown in Figure 30. Changes in the results of event processing during GSETT-3 are shown in Figure 31. Declines in the numbers of primary and auxiliary stations reflect changes toward IMS network configurations and removal of dialup stations from daily network status in IDC processing.

Installation of DFX and GA early this year produced a 40% drop in numbers of unassociated detections for primary stations compared with the high for GSETT-3, Version 3 and an 80% drop for auxiliary stations (Figure 30). The improved signal detection features of DFX and association capability of GA resulted in a 40% reduction, as a percentage of the REB, in the numbers of arrivals that analysts have had to retime and a 50% decrease in numbers of events they must add, since the Version 3 highs.

This period, the number of phase detections increased again by 25% for the primary network and tripled for the auxiliary network (Figure 30). Correspondingly, analysts have had to add fewer phases but rename more as a percentage of the REB. There was also a marked increase in the numbers of automatically formed and analyst-modified events (Figure 31). These changes are believed to reflect the new detection thresholds for 3C stations, since the number of events reaching the REB remained about the same as for last period.

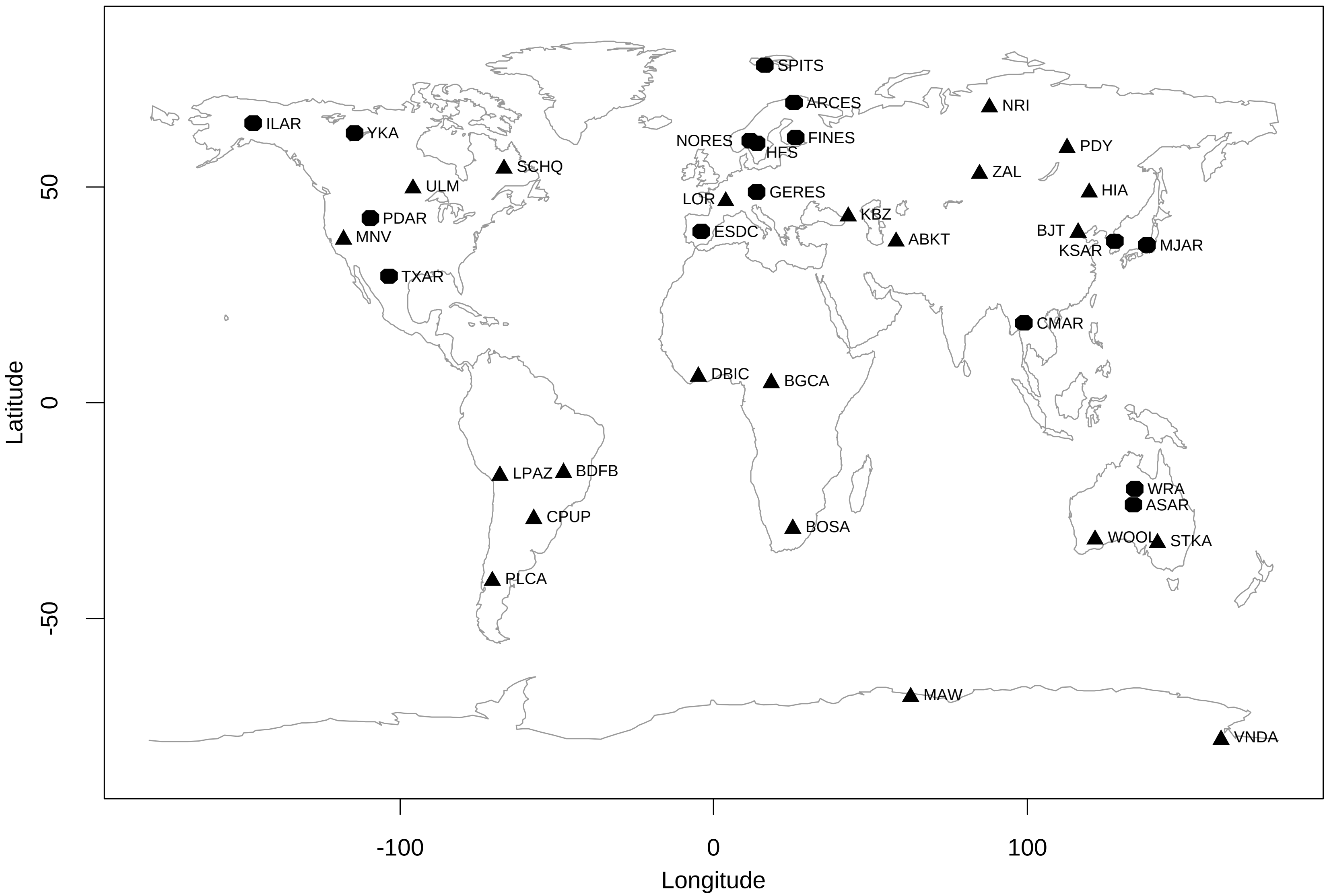


Figure 1. Geographical distribution of primary stations currently part of GSETT-3. Array stations and 3-C stations are marked as circles and triangles, respectively.

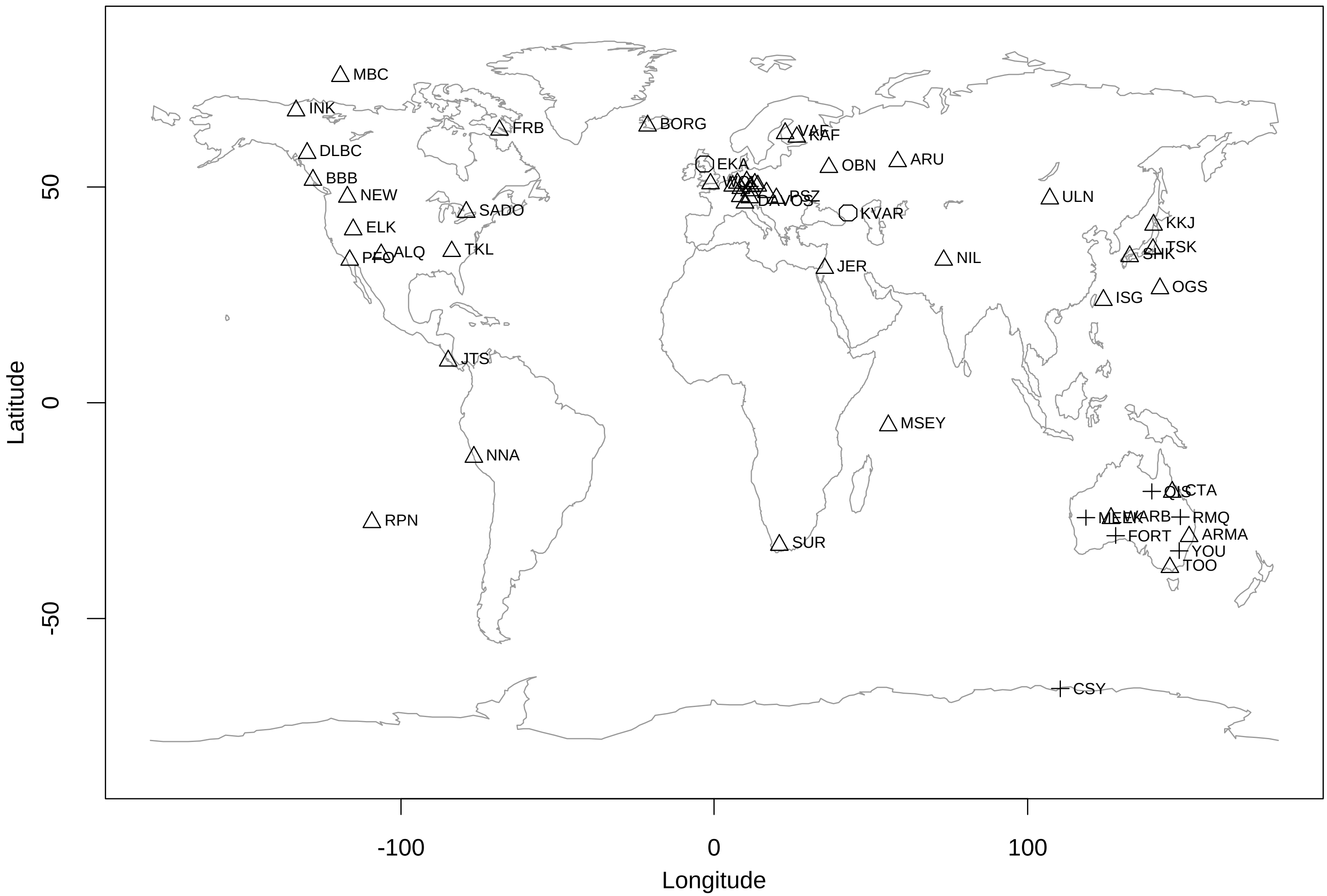


Figure 2. Current auxiliary stations. Arrays, 3-C stations, and 1-C stations are marked as circles, triangles, and plus signs, respectively.

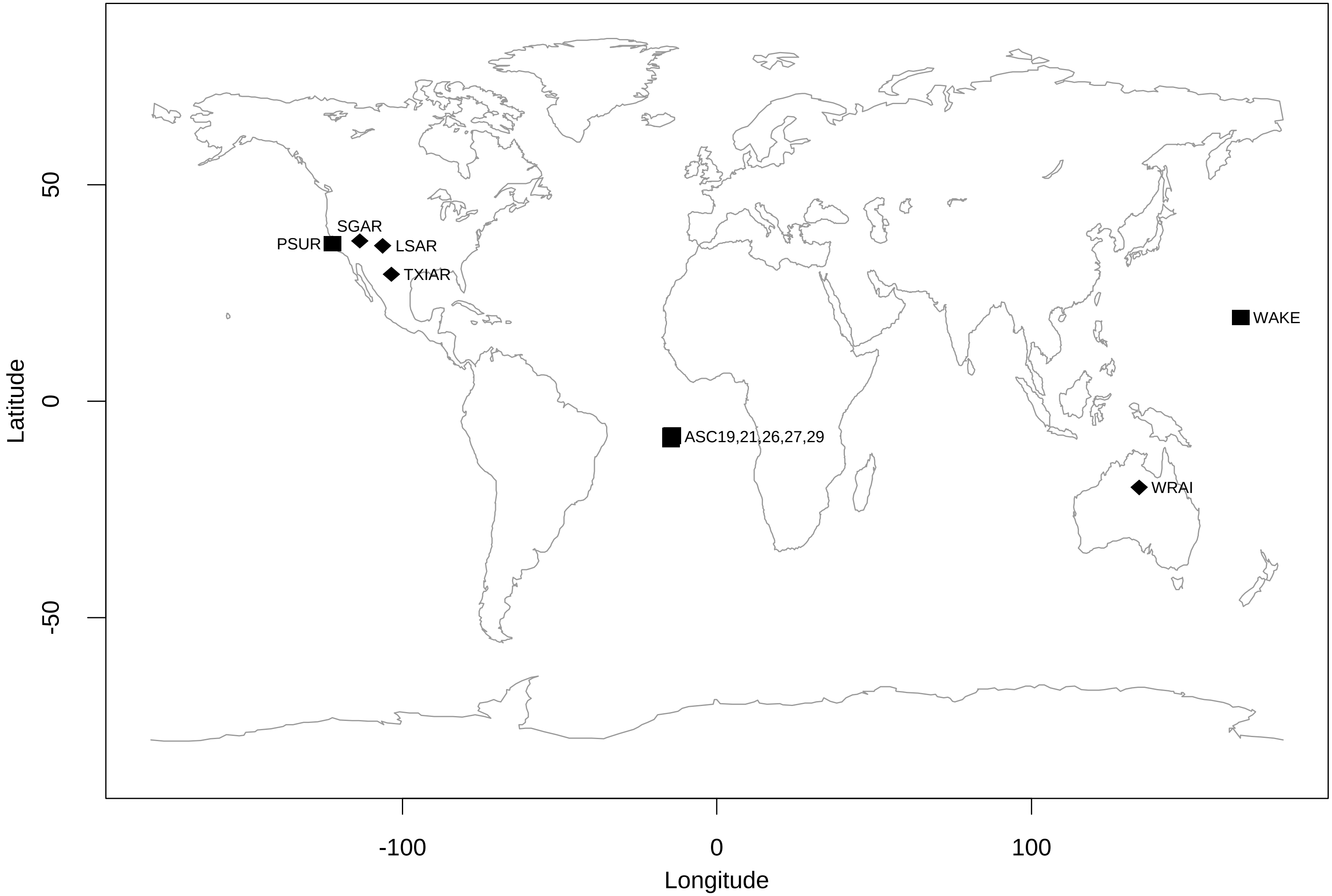


Figure 3. Hydroacoustic (squares) and infrasound (diamonds) stations for which the IDC is currently receiving data.

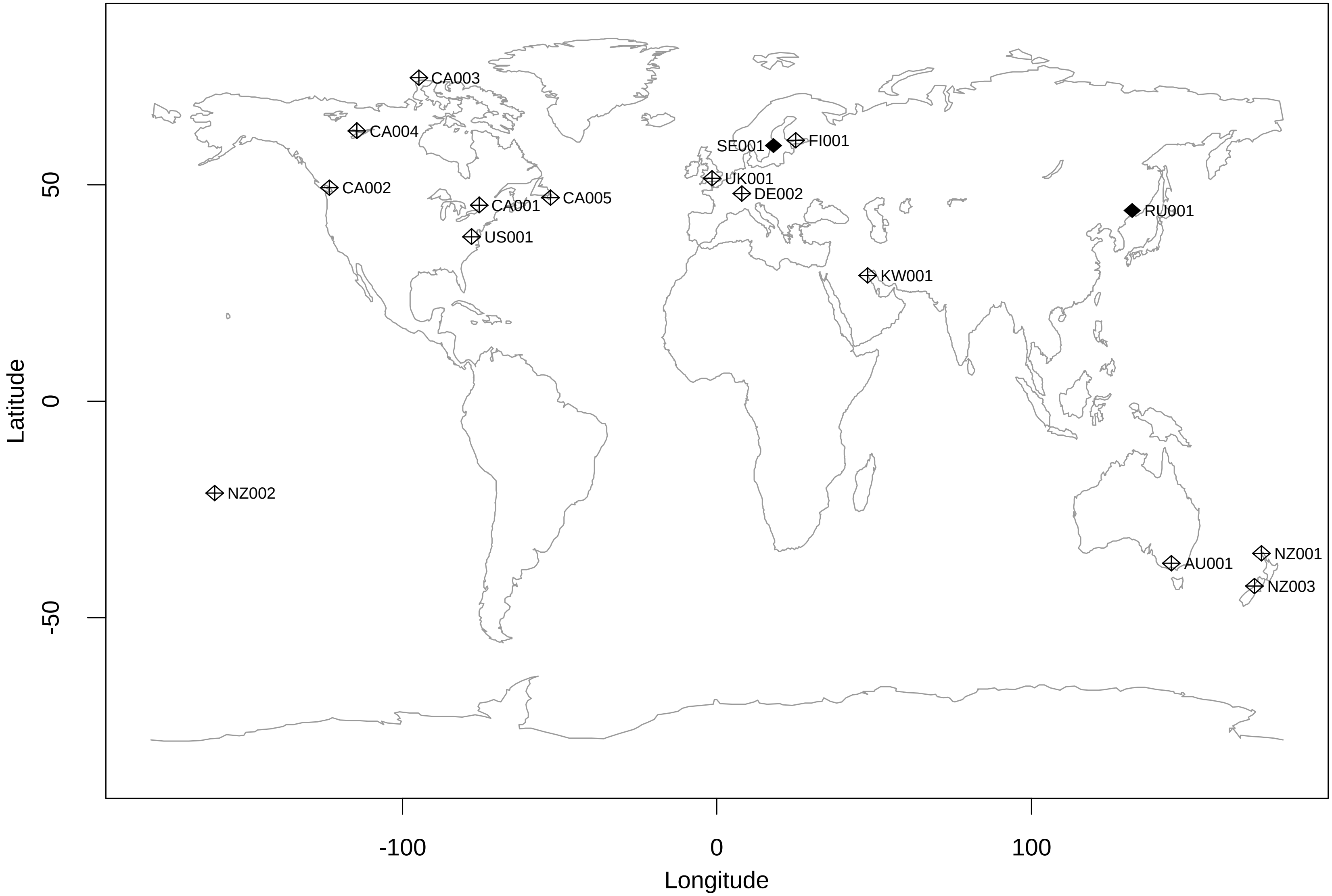


Figure 4. Radionuclide stations for which the IDC is currently receiving and reviewing data. The symbol indicates the type of data provided: open = gas, open with "+" = particulate; solid = both.

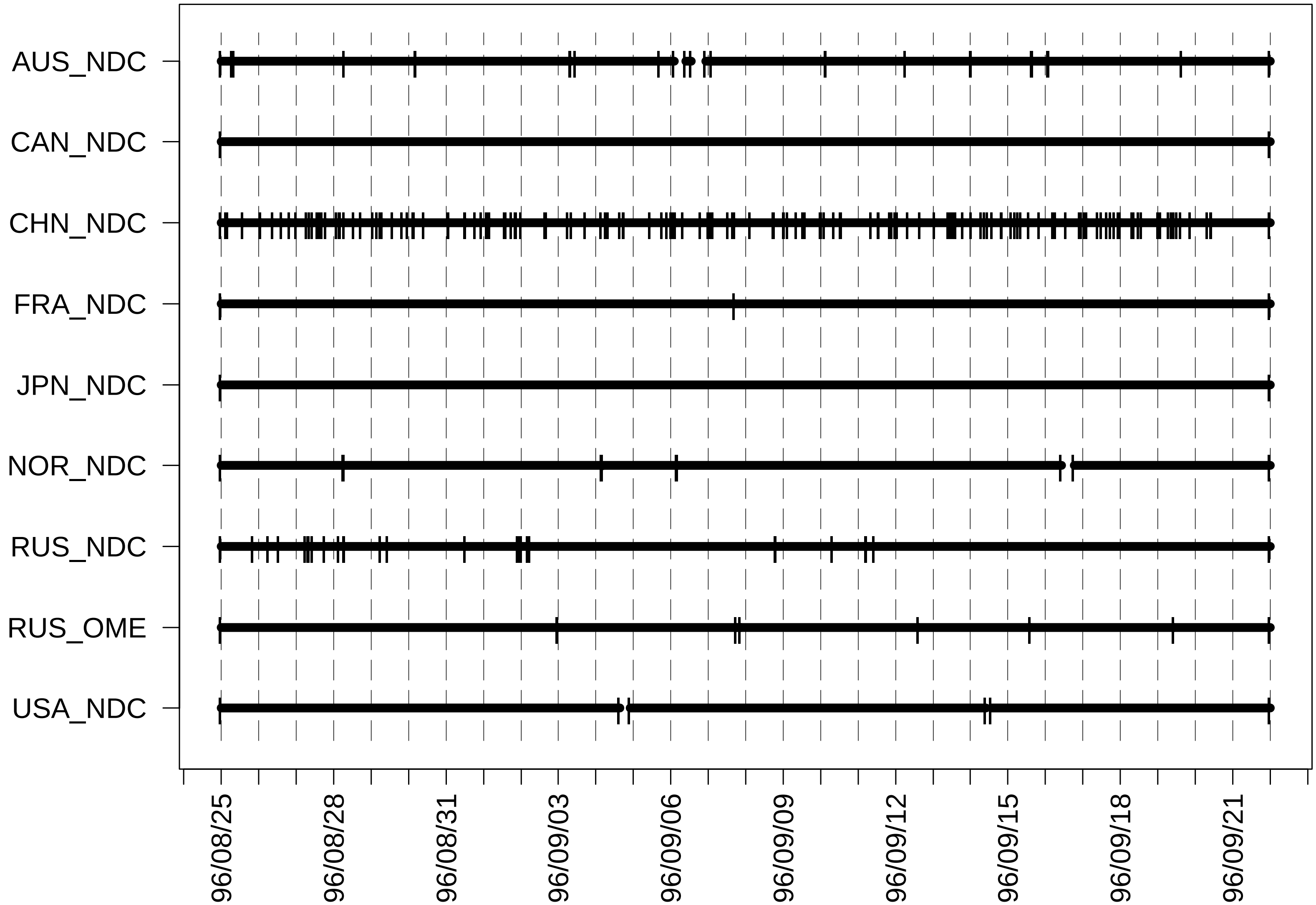
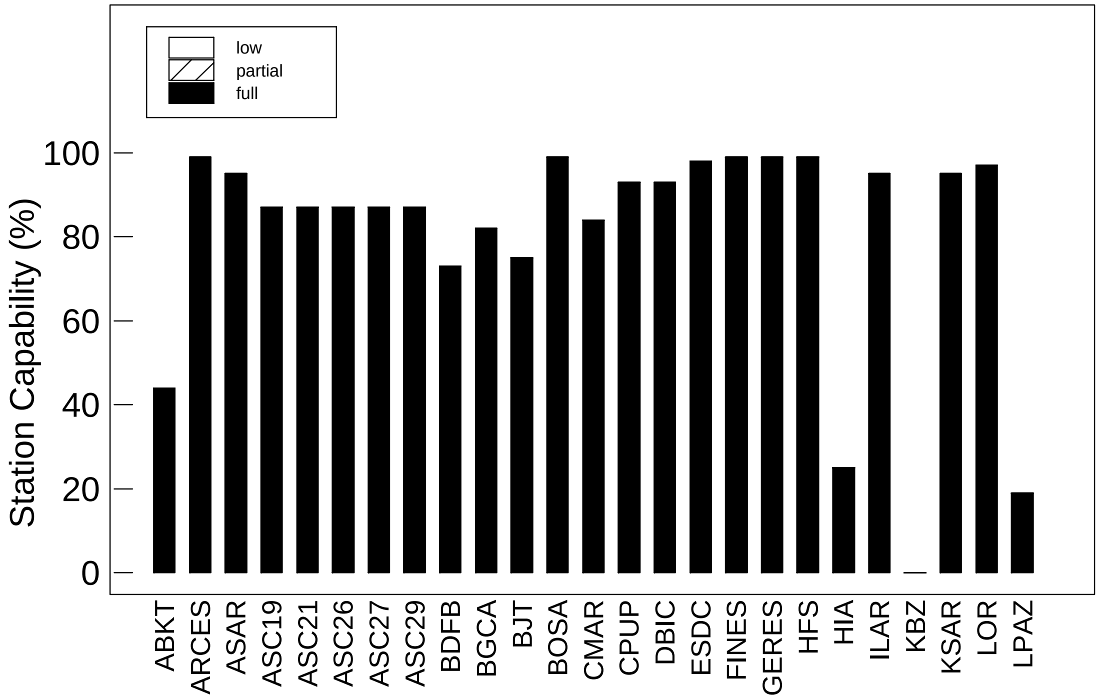


Figure 5. Connection histories of communication links from data centers to the International Data Center (IDC). Gaps in the time lines are bounded by tick marks and indicate breaks in communication. RUS_OME shows the link from Obninsk, Russia to the IDC.



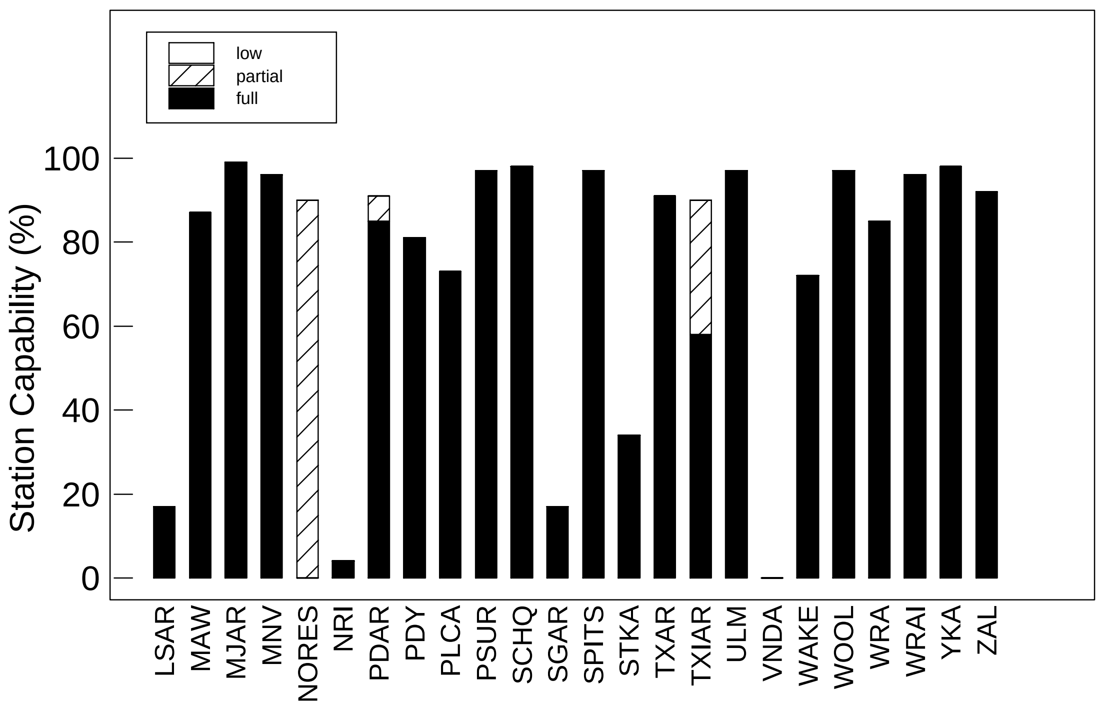


Figure 6. Capability of primary and acoustic stations as observed at the IDC. Capability categories are based on signal gain (SG), defined as the ratio of signal gain to the maximum theoretically possible for the station. Categories are: Full, SG >= 90%; Partial, 70% <= SG <= 90%; low, SG < 70%; Null, no data.

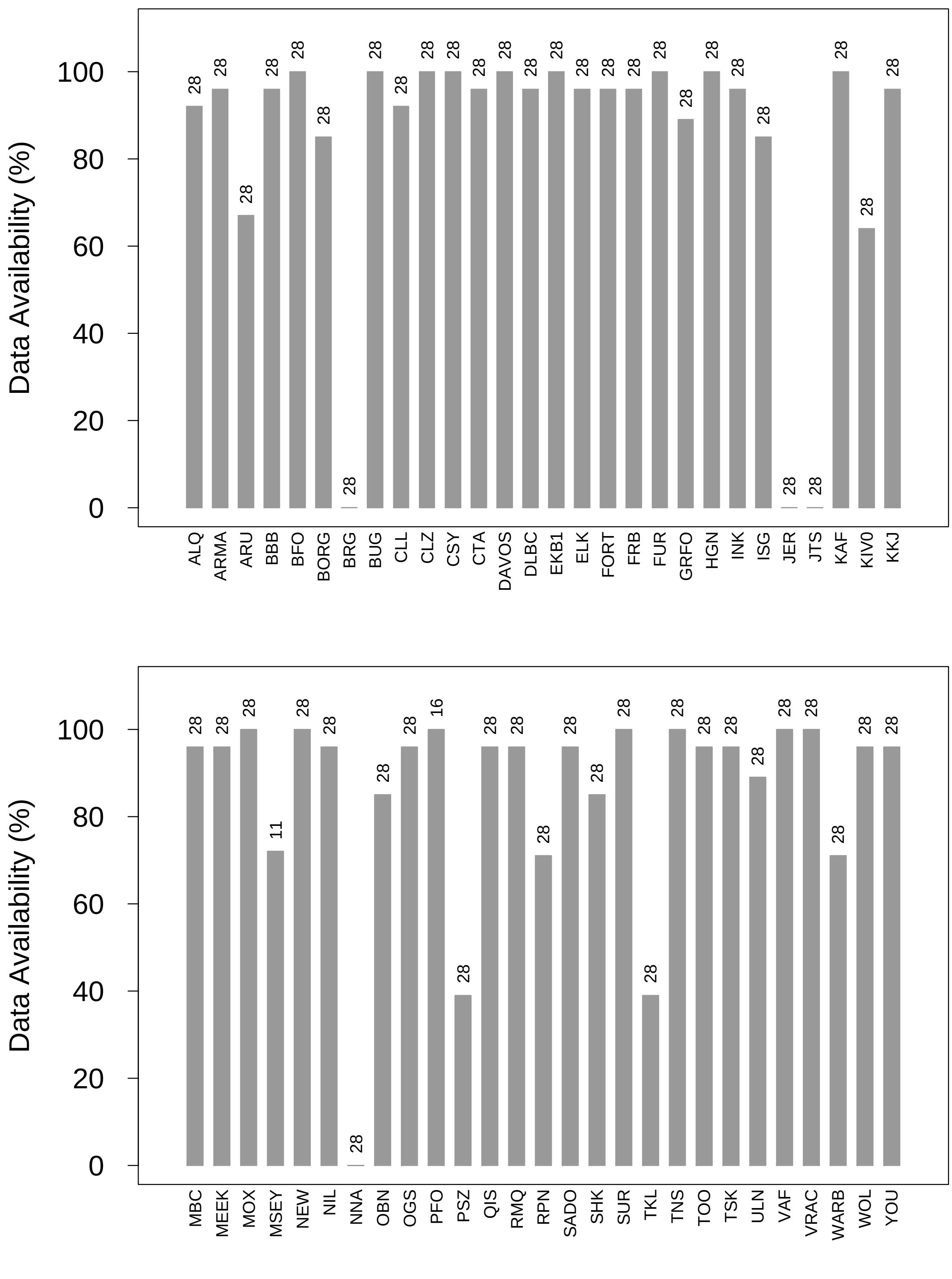
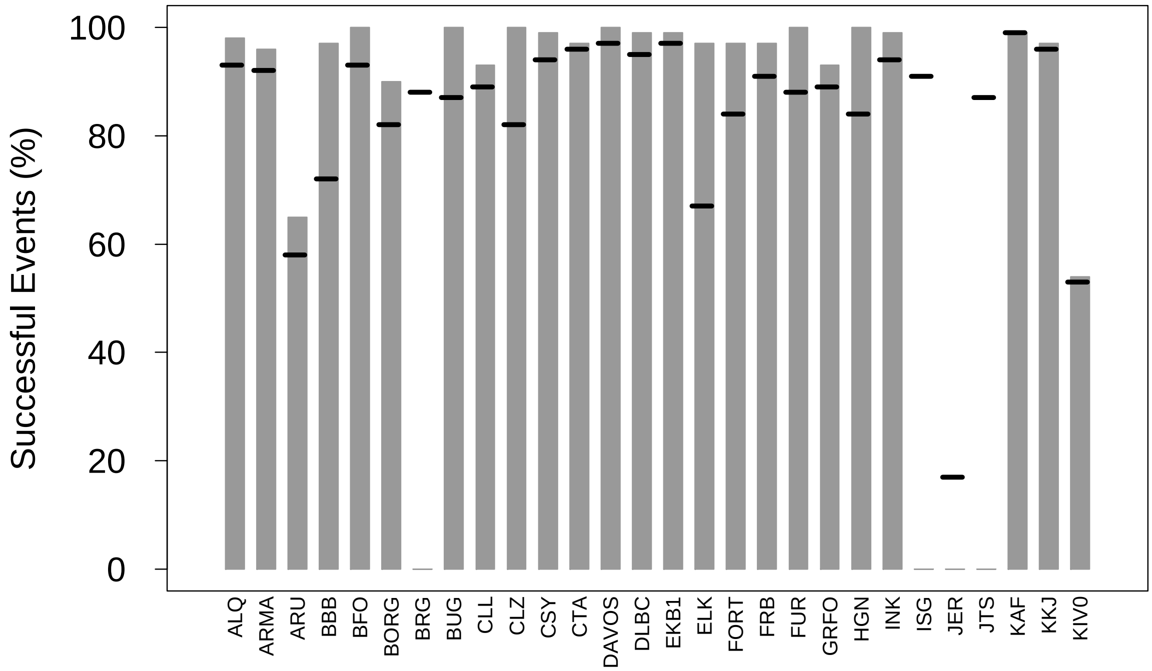


Figure 7. Availability of auxiliary station data. Bars indicate the percentages of pollings for which data were successfully retrieved from stations by the IDC. "Success" is regarded as at least 95% retrieval. Each station is polled once a day under normal circumstances. The number of completed polls is shown for each station. Only a single site is polled for each array station. Telephone stations are not shown.



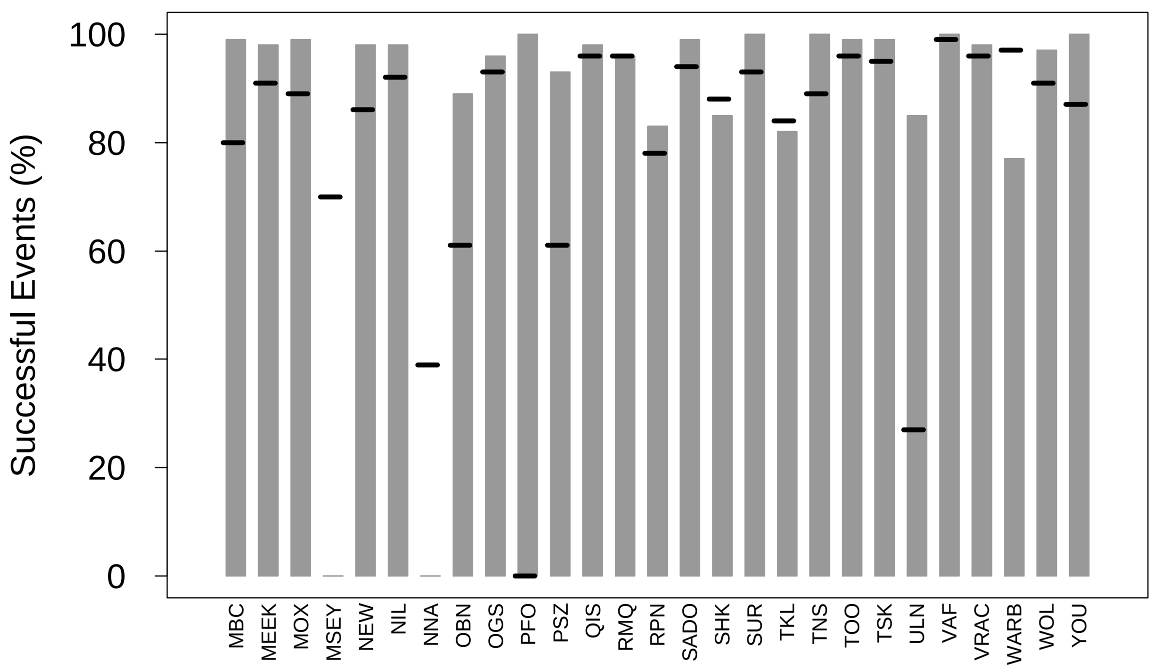


Figure 8. Percentage of times that requests for data from auxiliary stations were successful for distinct events in the AEL. Tick marks indicate percentages since January 1, 1996. Telephone stations are not shown.

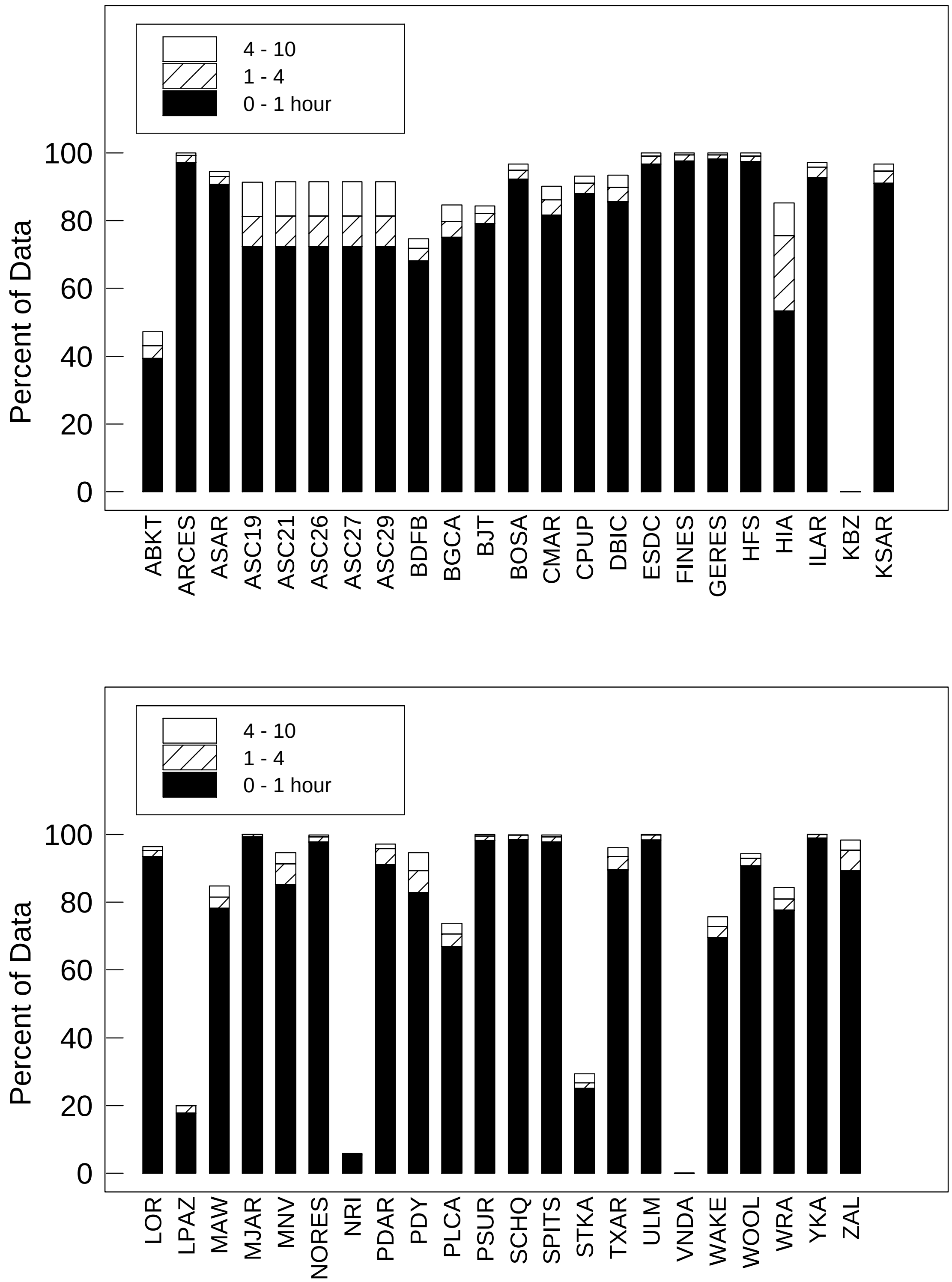


Figure 9. Time delay from event origin time to receipt at the IDC for primary and hydroacoustic data. Null space above bars indicates the percentage of data that took more than 10 hours to arrive.

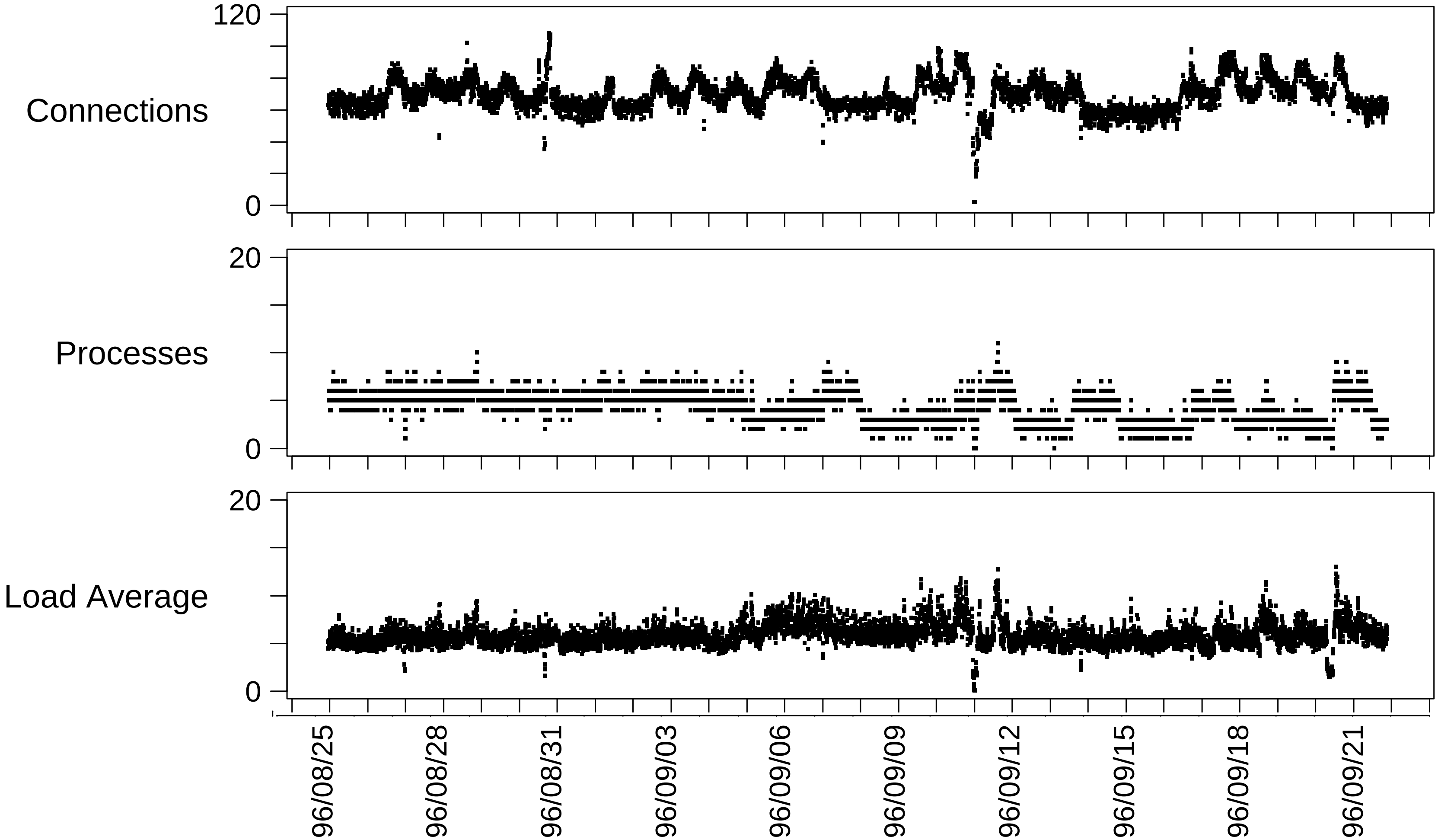


Figure 10. Performance of the operational database, alsvid, at 5-minute intervals. Connections show the number of processes connected to the Oracle database, which is licensed for 144 connections. Processes show the number of processes running on the operational Oracle instance; at any given time, the majority of connects are idle. The load average is the load averaged over 5 minutes on the eight-processor SPARCcenter 1000 used as the operational database server.

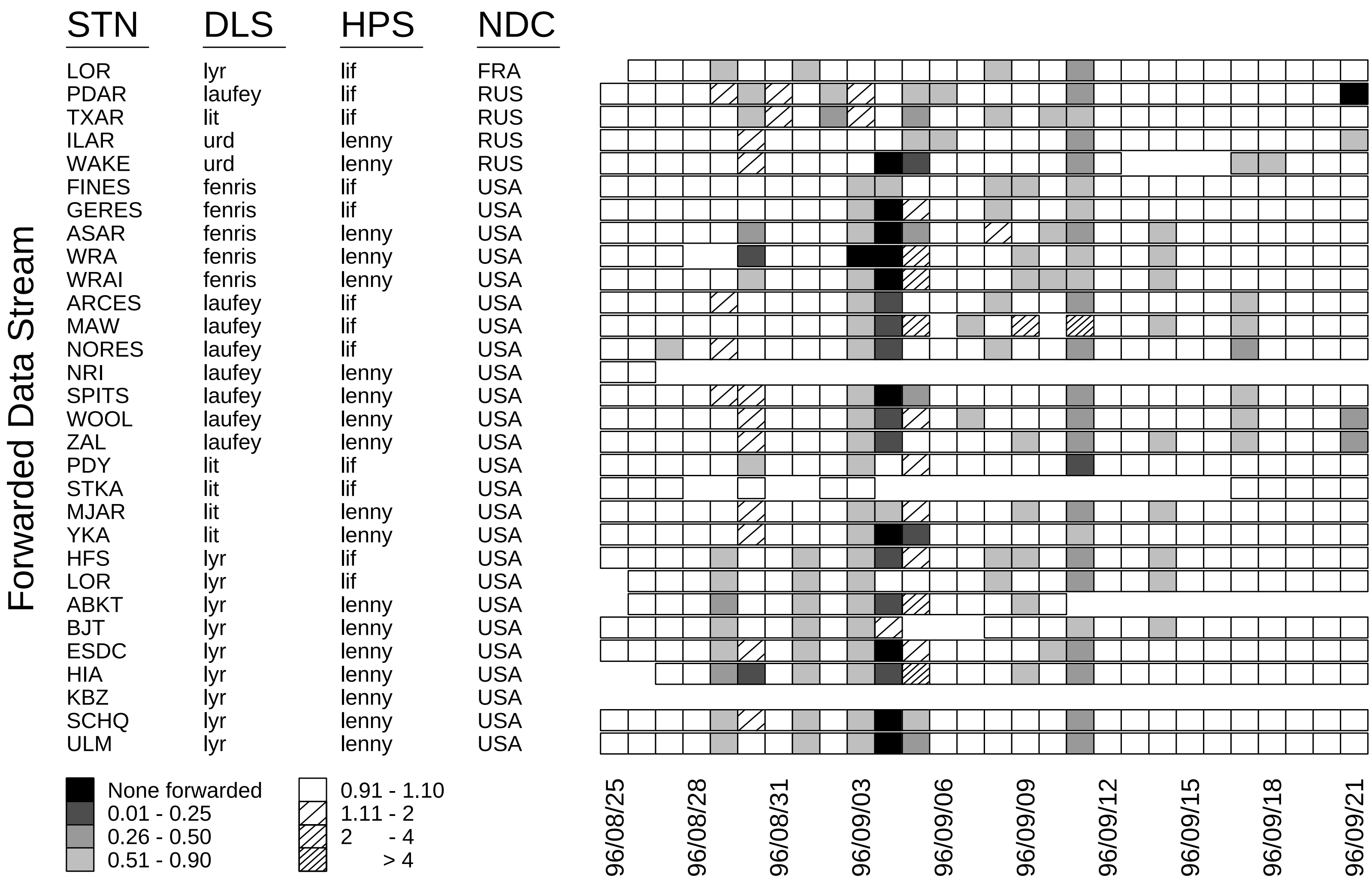


Figure 11. Progress of continuous waveform forwarding from the IDC to subscribing NDC's. Data streams are grouped by NDC, followed by diskloop server (DLS) and heap (buffer) server (HPS).

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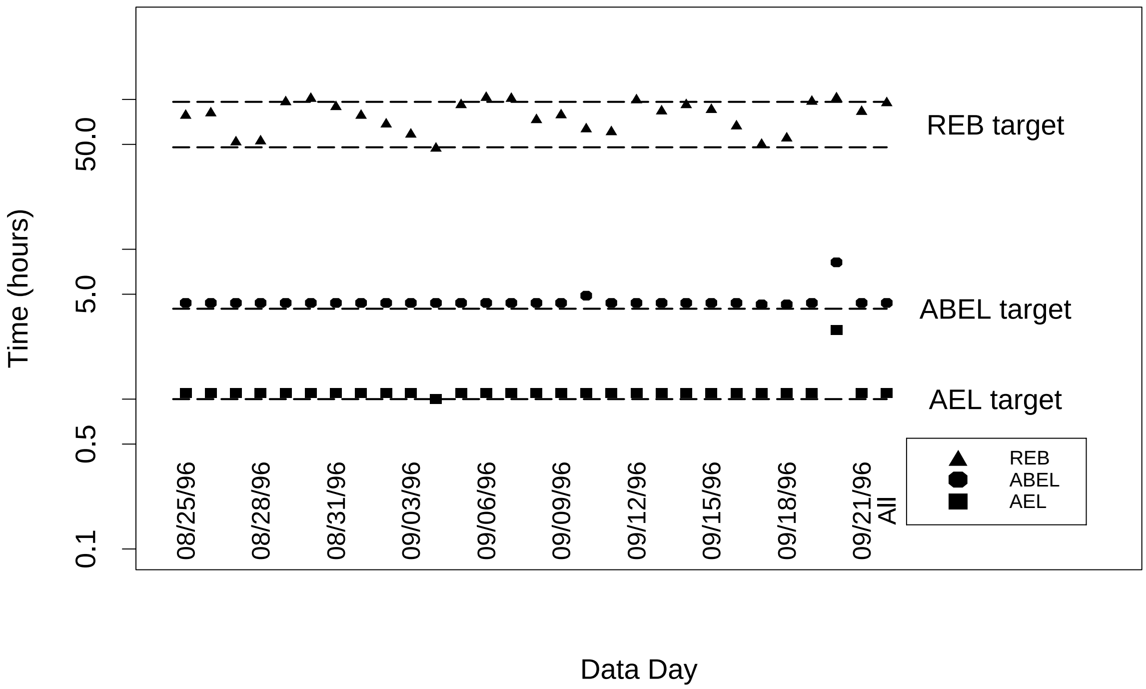
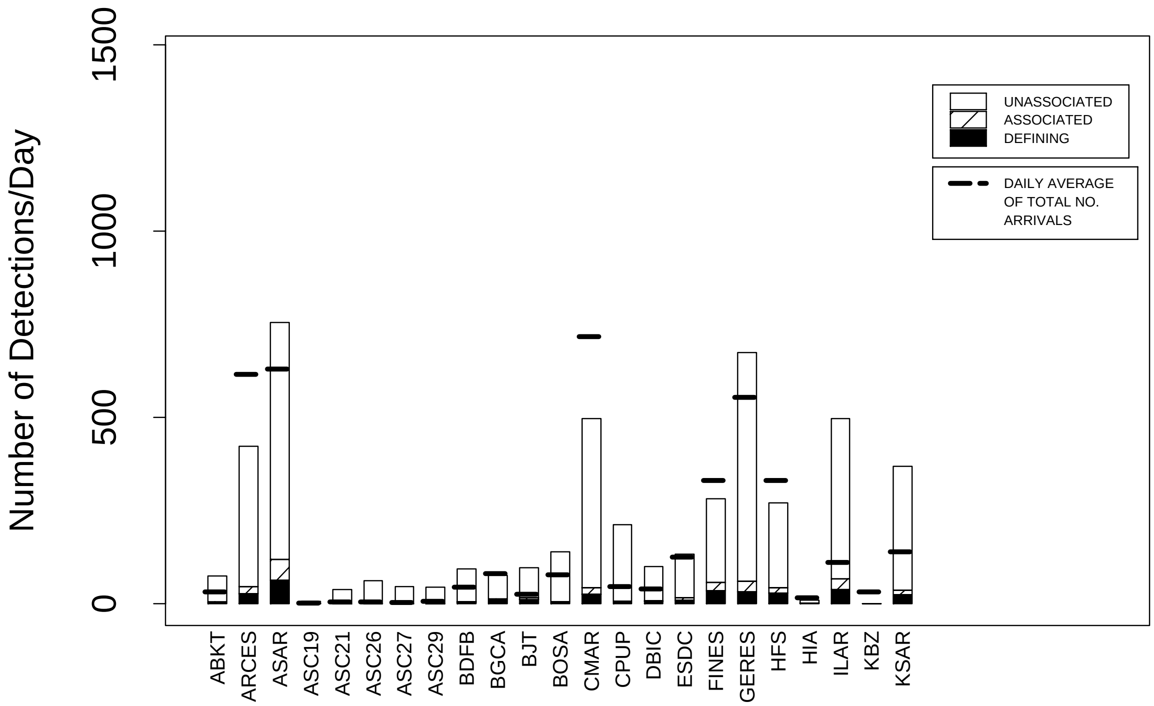


Figure 12. Time of entry of 90% of the events into the database for the AEL, ABEL, and REB for this period. Target times for completion of automatic bulletins are 1 hour (AEL), and 4 hours (ABEL) after each event's origin time. The target time for the REB is 2 to 4 days after the end of the data day, which is 48 to 96 hours after events' origin times.



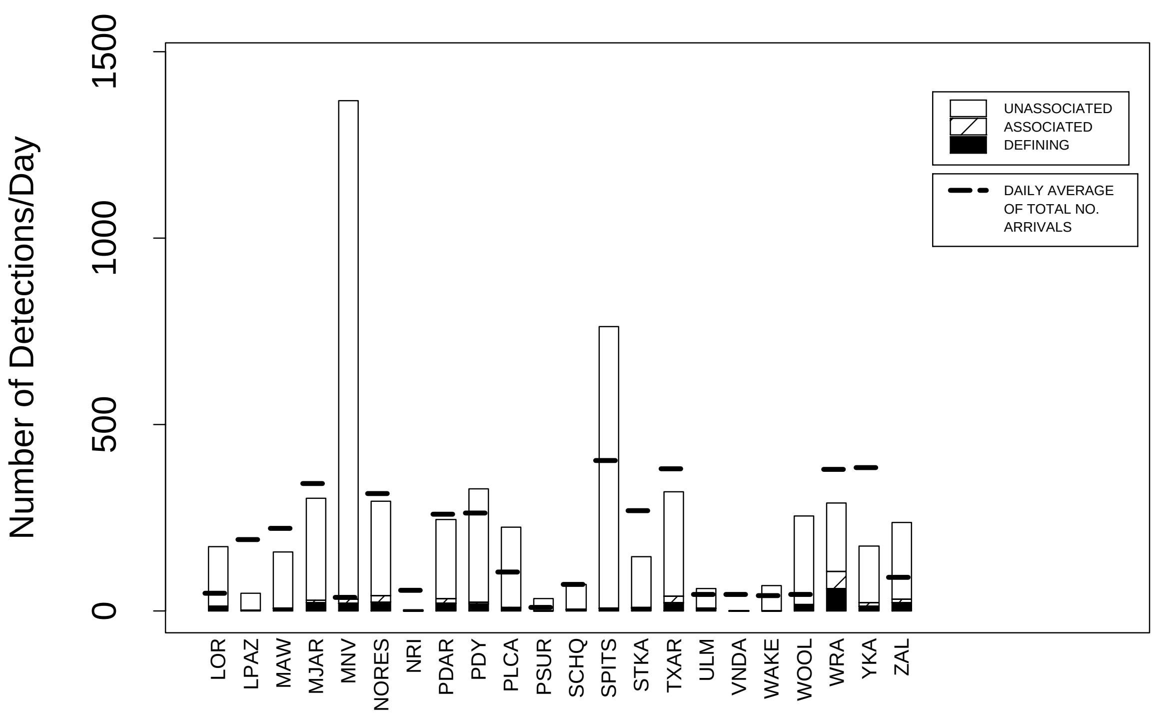
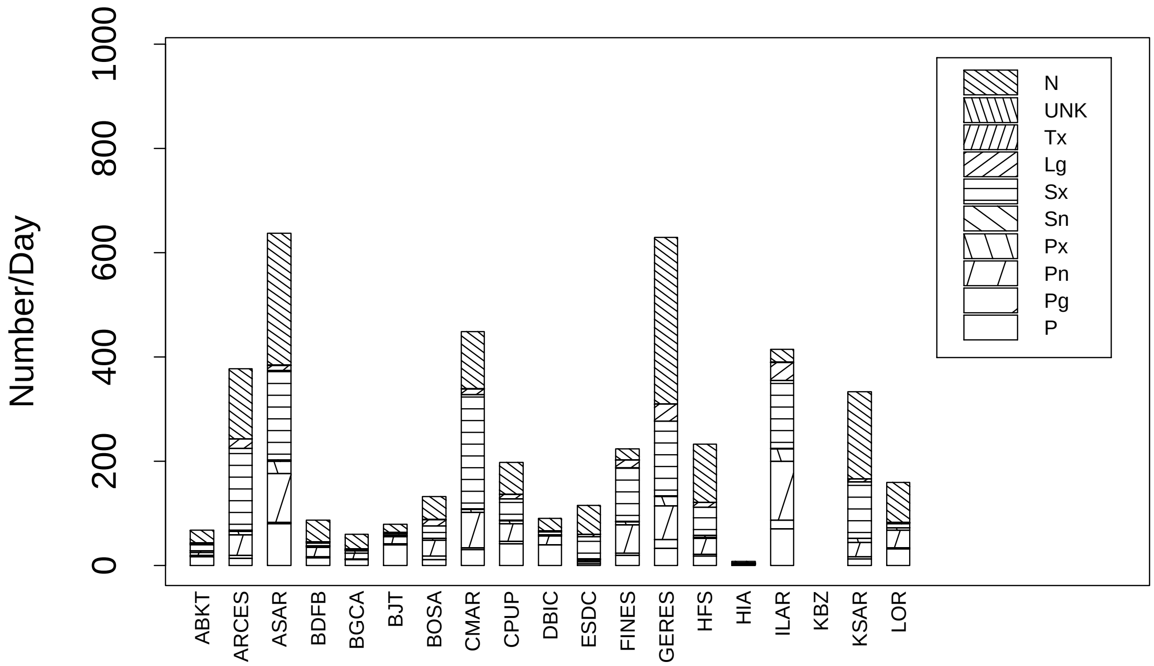


Figure 13. Numbers of automatic detections per day for primary and acoustic stations. Detections are from the DEL where each detection is either a defining phase, an associated but non-defining phase or an unassociated phase. Dashed lines show averages previous to this period since January 1, 1996.



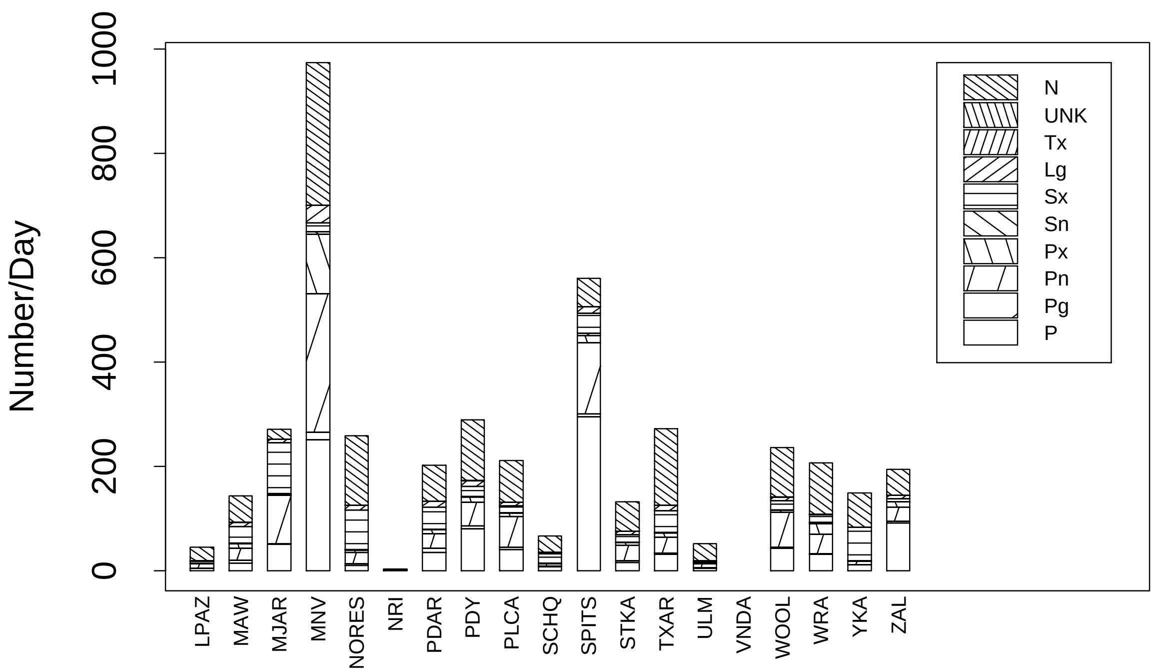


Figure 14. Numbers of arrivals per day that were unassociated for primary stations. Phase identifications are from the DEL.

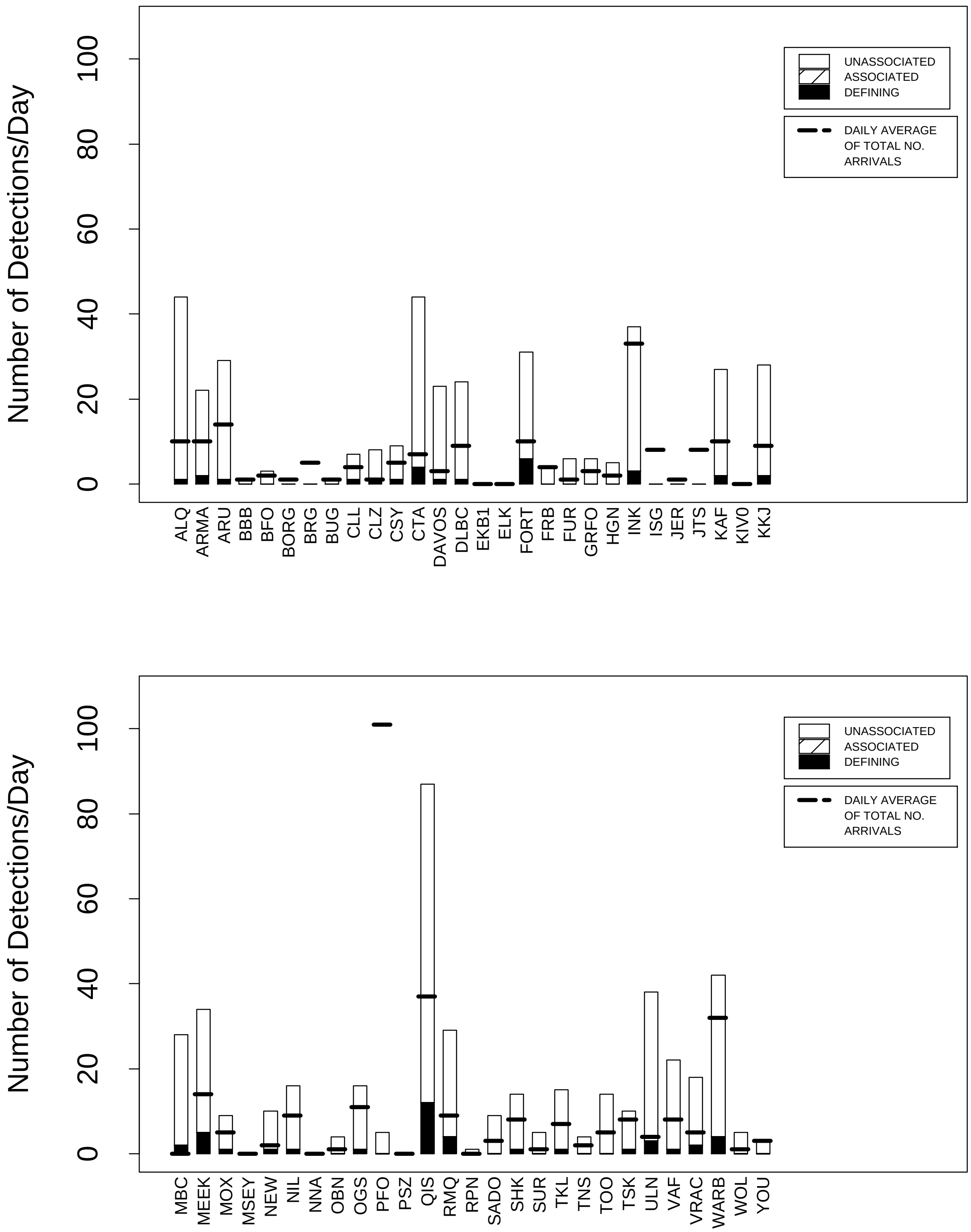


Figure 15. Number of automatic detections per day for each auxiliary station. Detections are from the DEL where each detection is either a defining phase, an associated but non-defining phase or an unassociated phase. Dashed lines show averages previous to this period since January 1, 1996. Telephone stations are not shown.

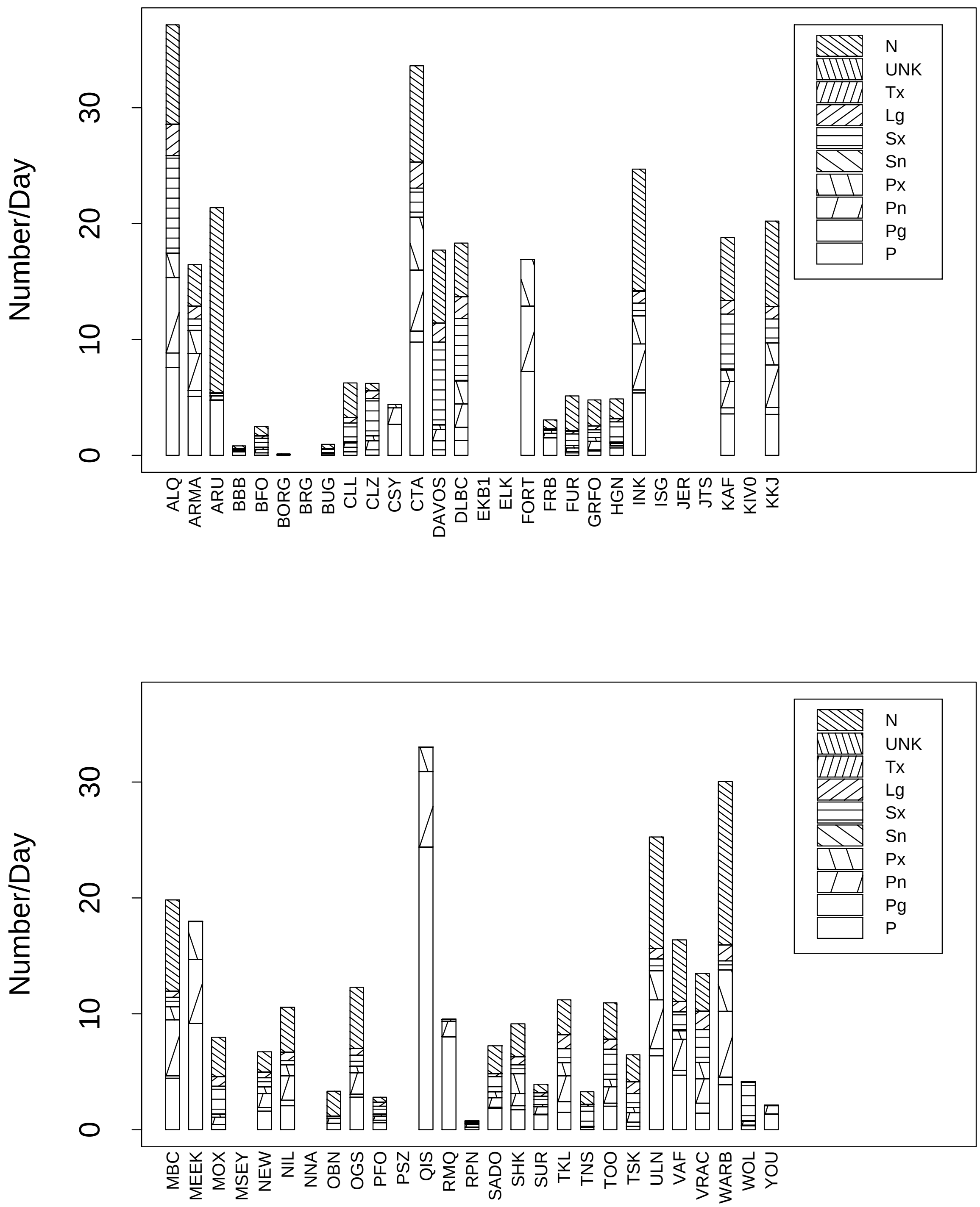


Figure 16. Number of arrivals per day that were unassociated for each auxiliary station. Phase identifications are from the DEL. Telephone stations are not shown.

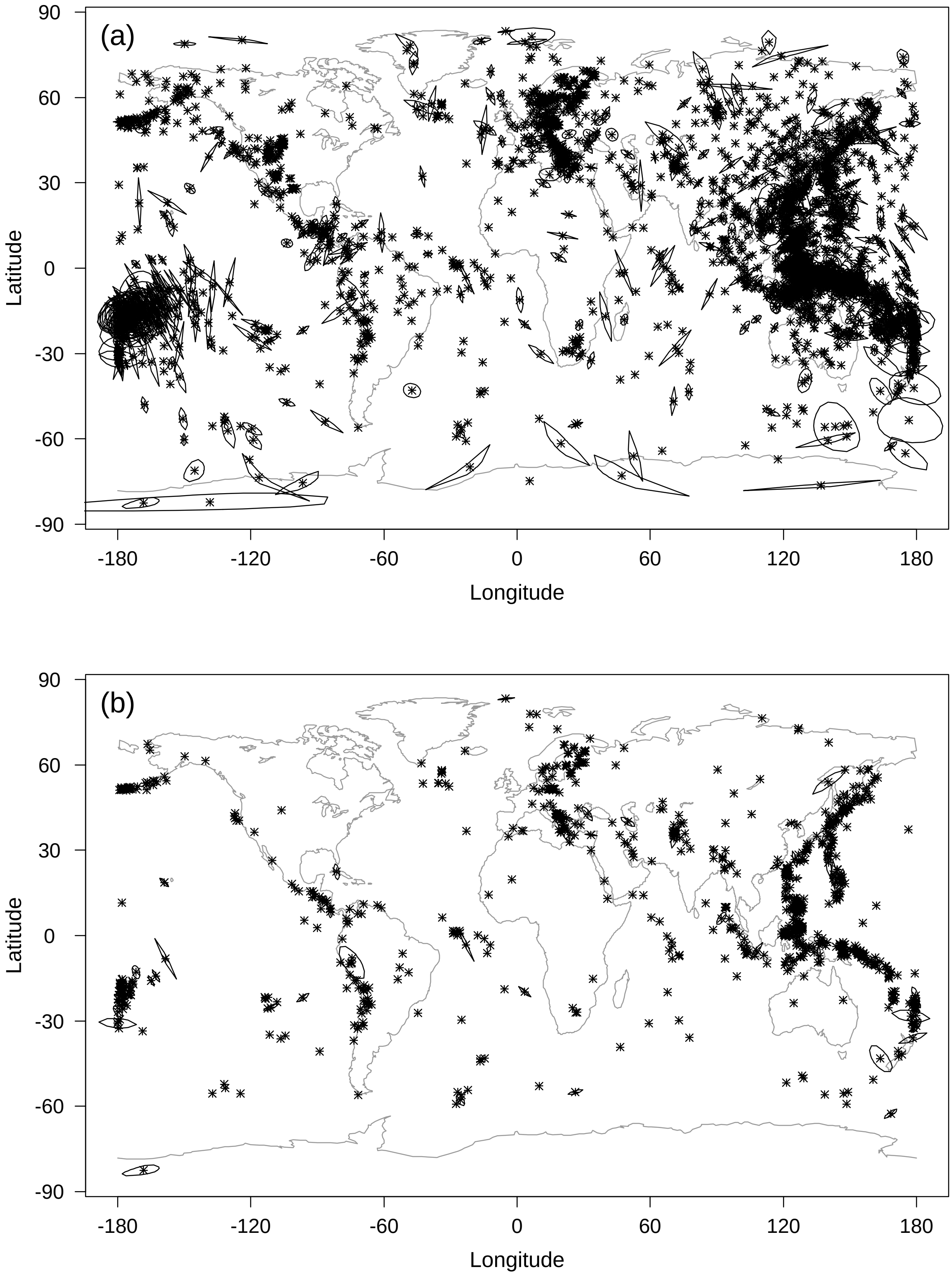


Figure 17. (a) All DEL events in the world for the period of this report. (b) Events from (a) with at least 6 defining phases. Ellipses are 90% confidence limits and, in (b), are usually smaller than the asterisk.

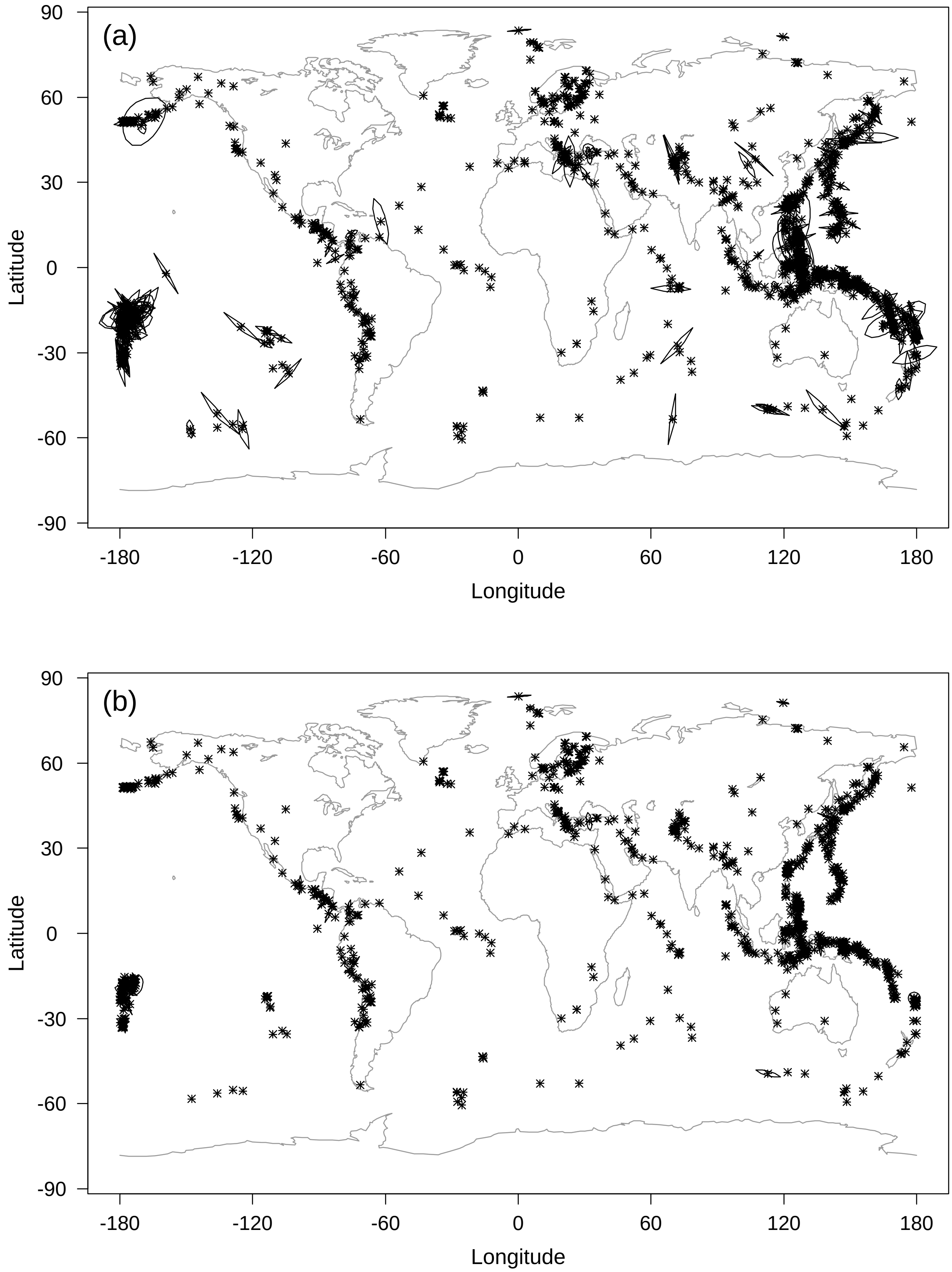


Figure 18. (a) All REB events in the world for the period of this report. (b) Events from (a) with at least 6 defining phases. Ellipses are 90% confidence limits and, in (b), are usually smaller than the asterisk.

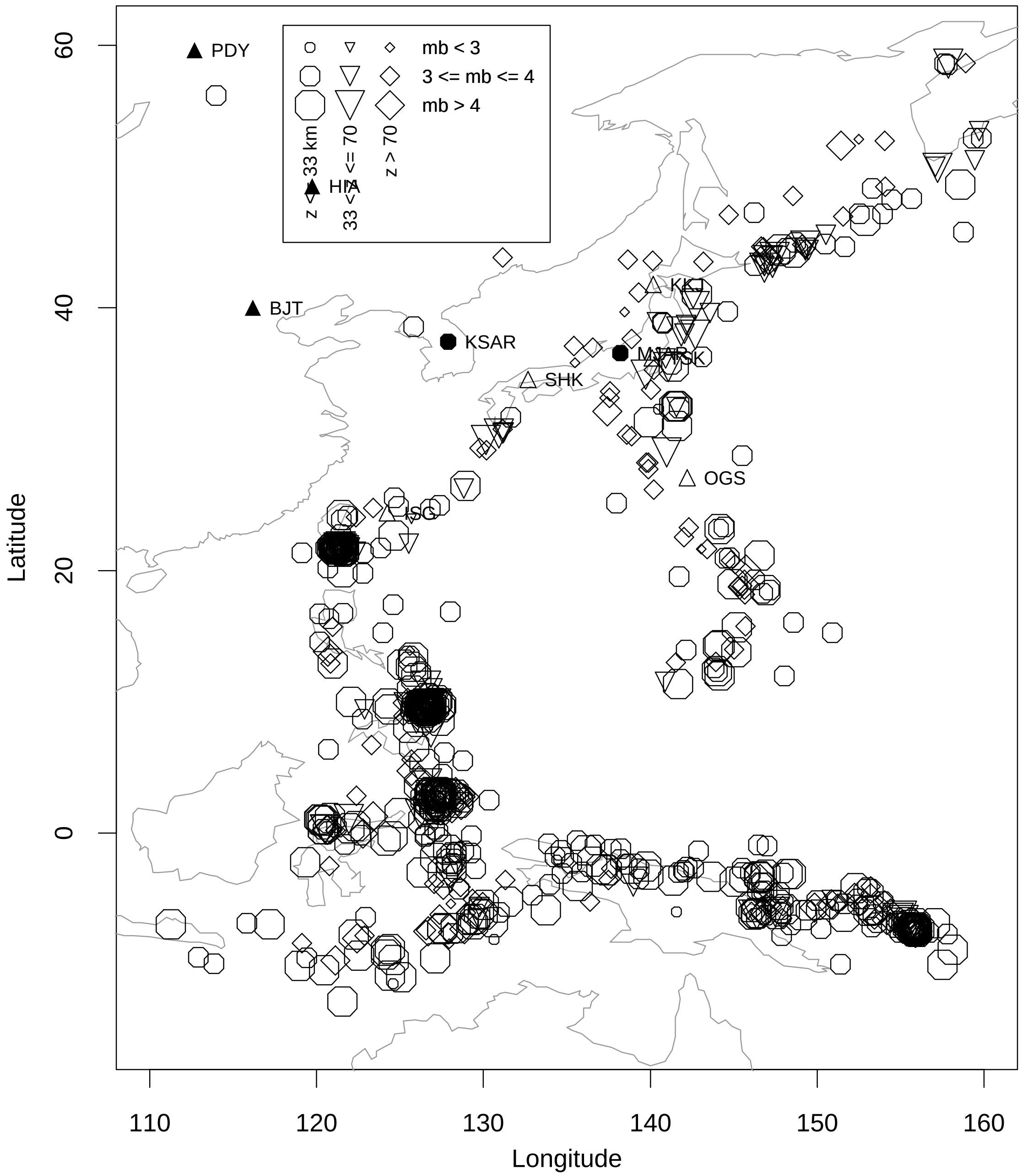


Figure 19. REB events in the western Pacific showing the depth and body-wave magnitude ranges. Error ellipses were left out for clarity. Primary and auxiliary stations are marked with filled and unfilled symbols respectively. Array stations and 3-C stations are marked as circles and triangles respectively. One-component stations appear as plus signs.

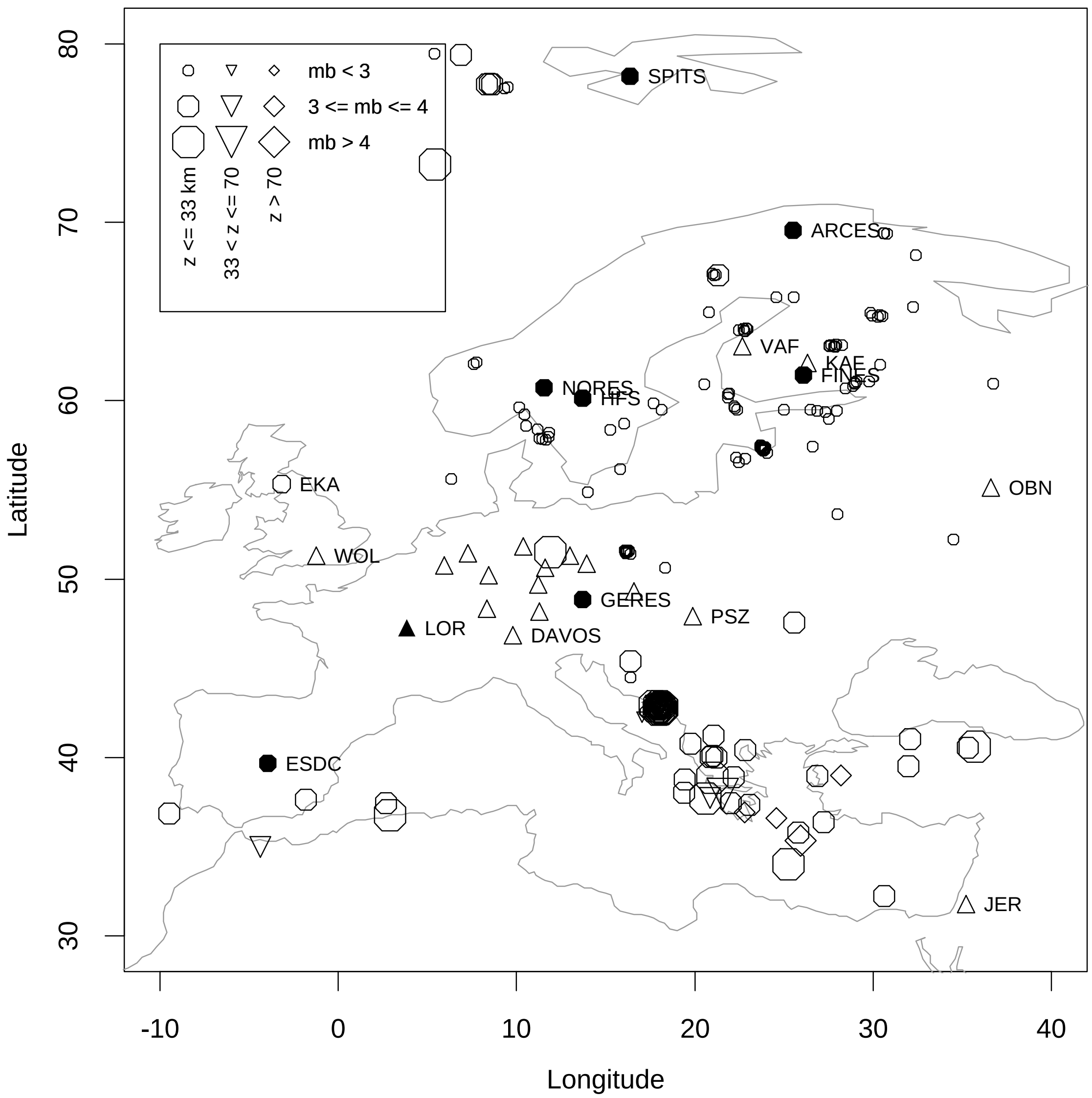


Figure 20. REB events in Europe showing the depth and body-wave magnitude ranges.

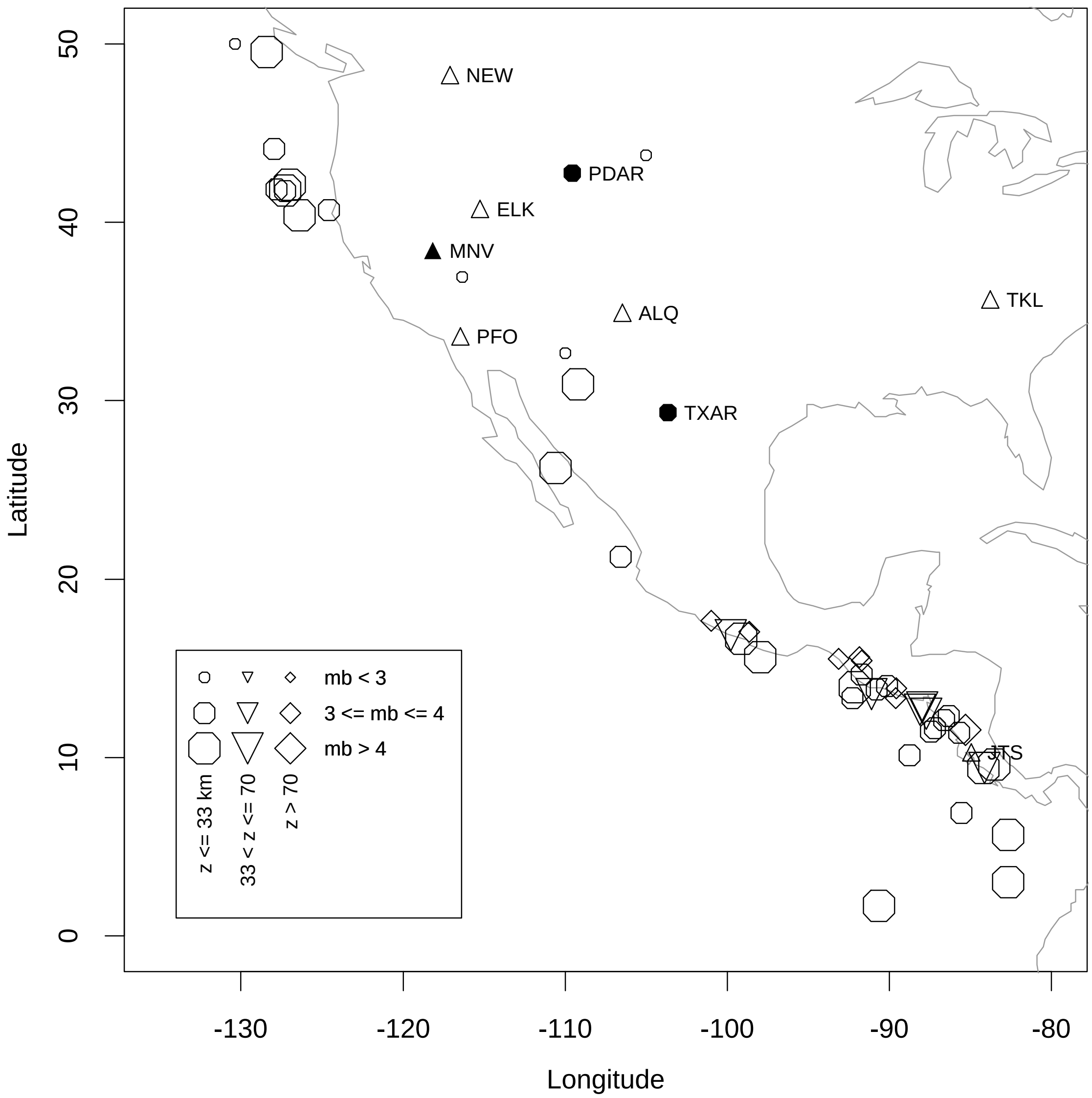


Figure 21. REB events in the western United States and central America showing the depth and body-wave magnitude ranges.

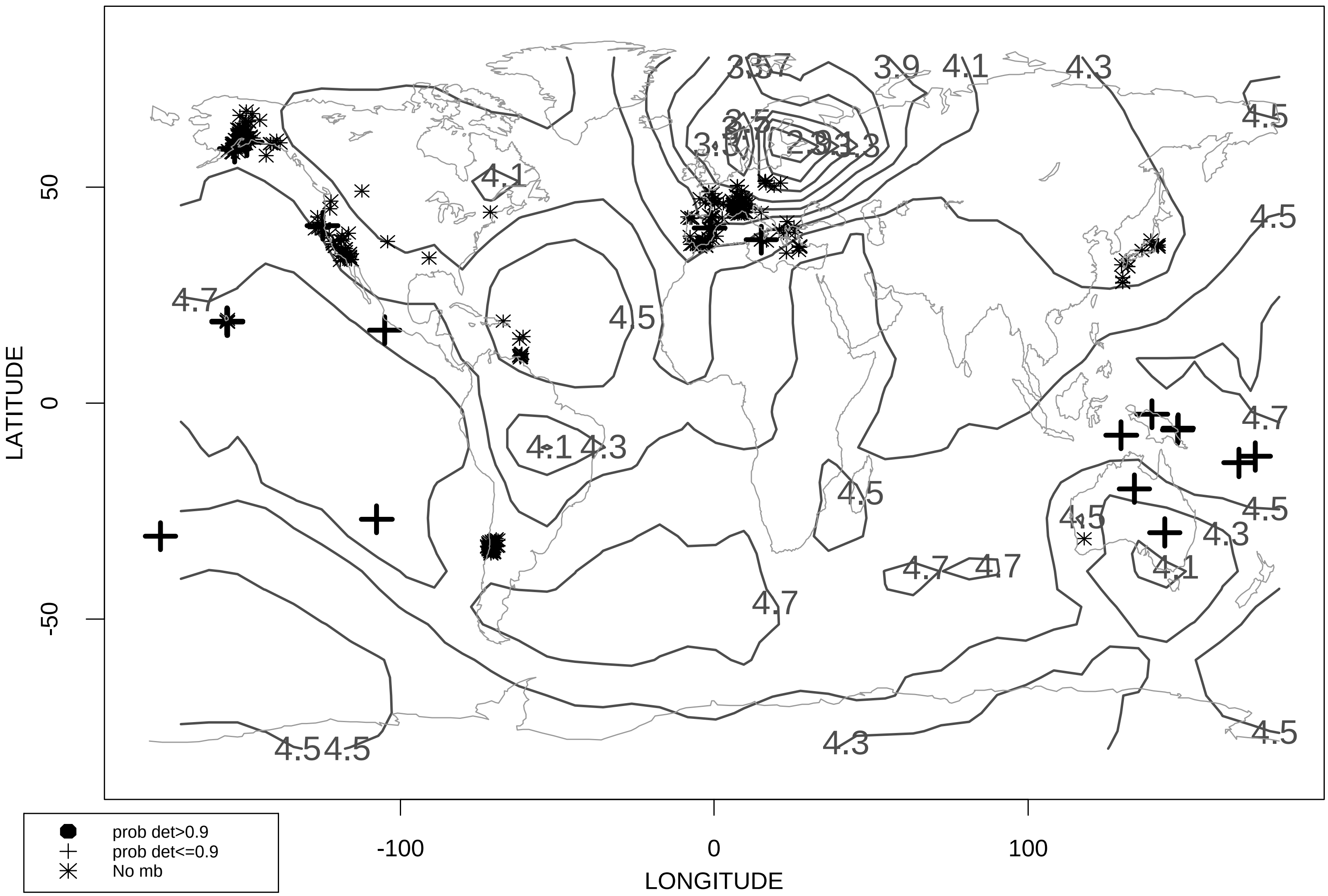


Figure 22. Events reported in the Quick Epicenter Determination (QED) for last period but not in the REB. Contours show estimated detection capability at 90% probability for the primary network with three P detections. Solid circles, if any, are events in the QED that were not in the REB and had a probability of detection by the GSETT-3 network > 90%. Plus signs show events in the QED that are not in REB but had 90% or less detection probability. Asterisks are events in the QED for which no m_b was reported and no estimate of detection probability can be made.

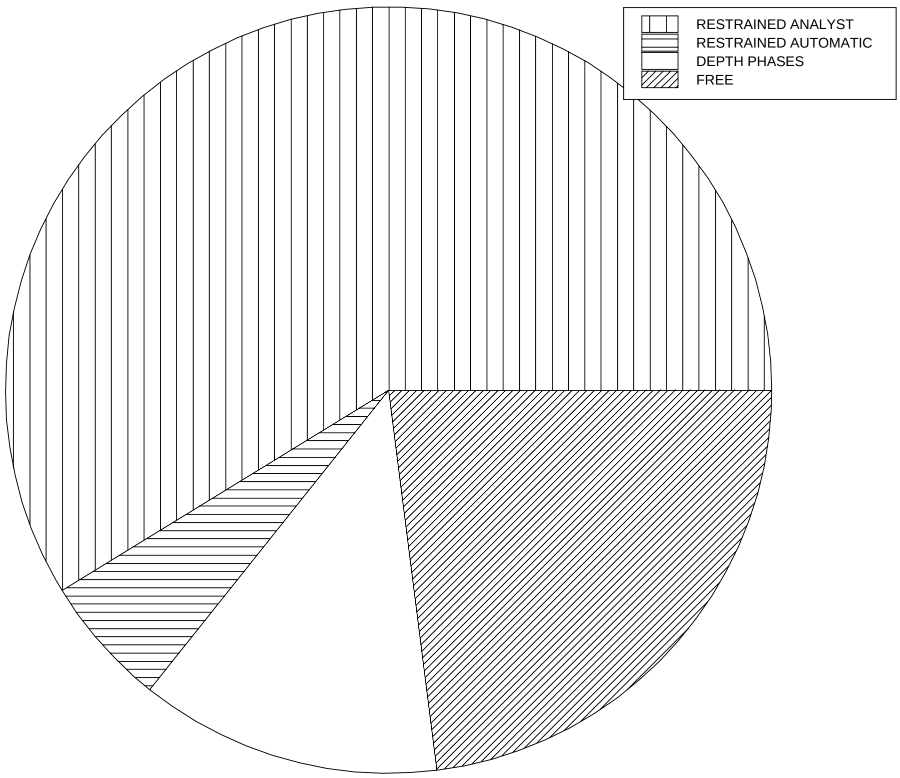


Figure 23. Depth constraints for events in the REB for the current period.

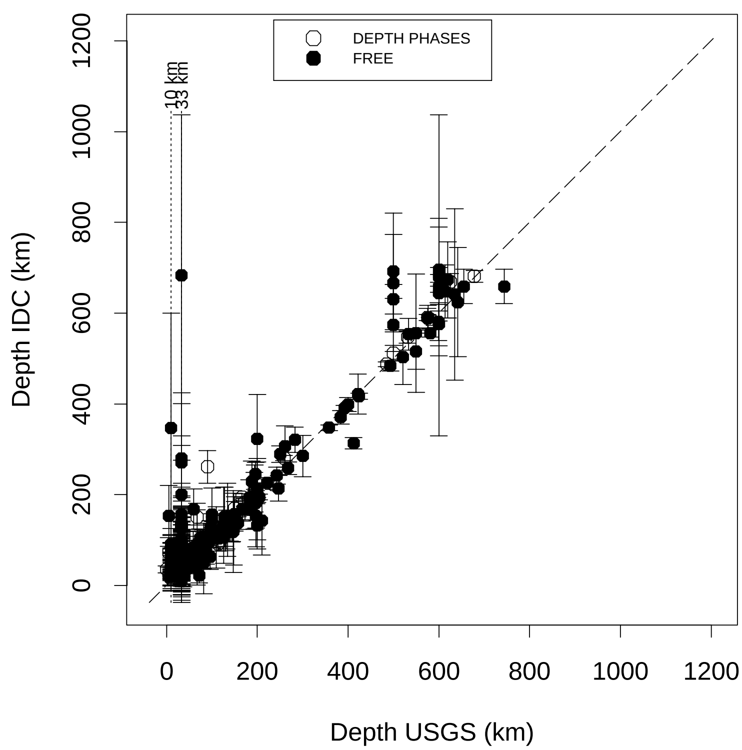


Figure 24. Comparison of unconstrained depths in the REB with depths reported in the QED for common events.

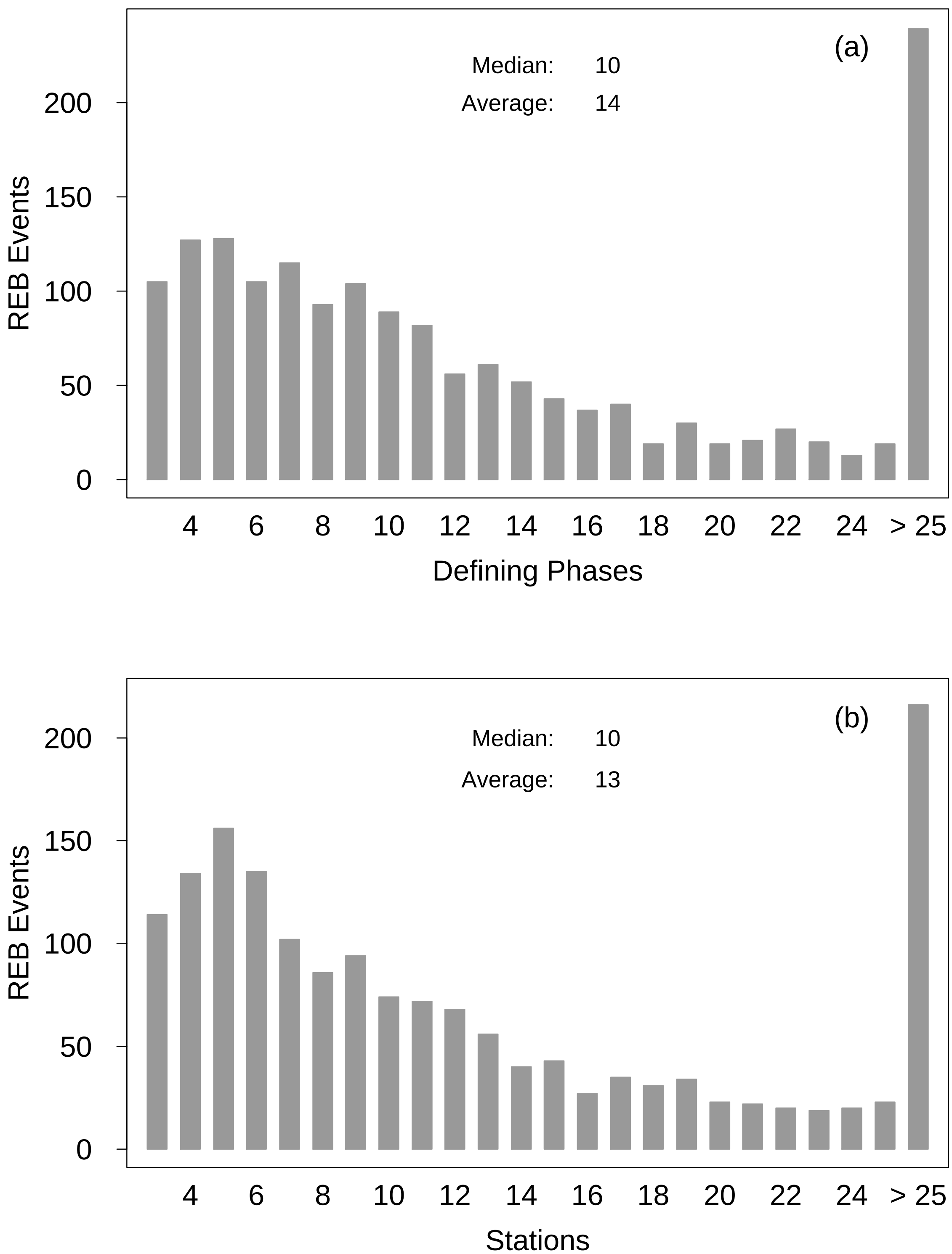


Figure 25. Numbers of events in the REB versus numbers of (a) defining phases and (b) primary and auxiliary stations.

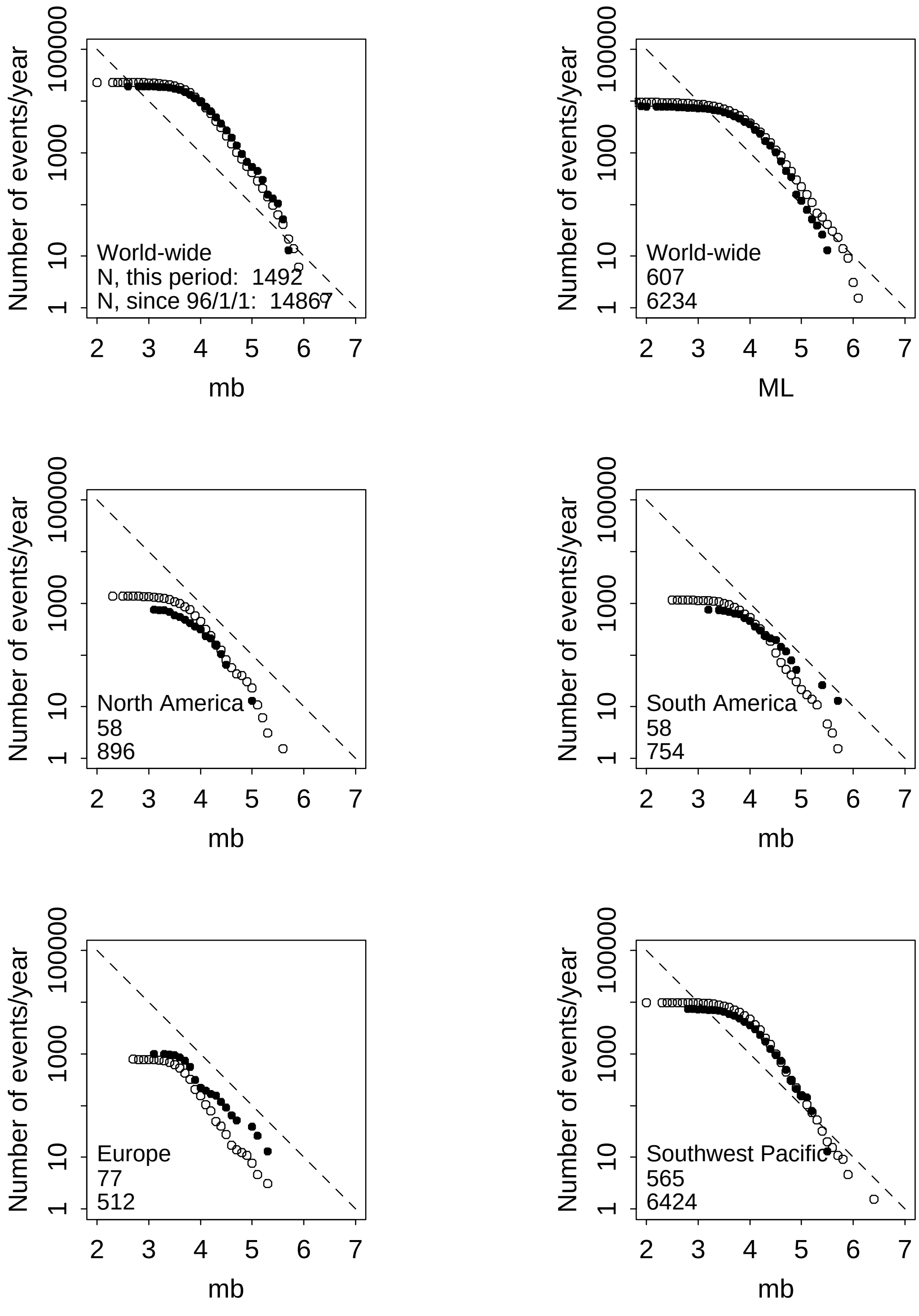


Figure 26. Recurrence distribution of body-wave (m_b) and local (ML) magnitudes in the REB for selected regions. Solid dots are for the current period, and open dots are for the previous time since 96/1/1. Posted numbers include all magnitudes > 0. The dashed lines have one-to-one slopes. Regions are defined as: North America 10^o N - 90^o N, 165^o W - 50^o W; South America 80^o S - 10^o N, 90^o W - 30^o W; Europe 30^o N - 80^o N, 15^o W - 30^o E; Southwest Pacific 80^o S - 0^o, 60^o E - 150^o W.

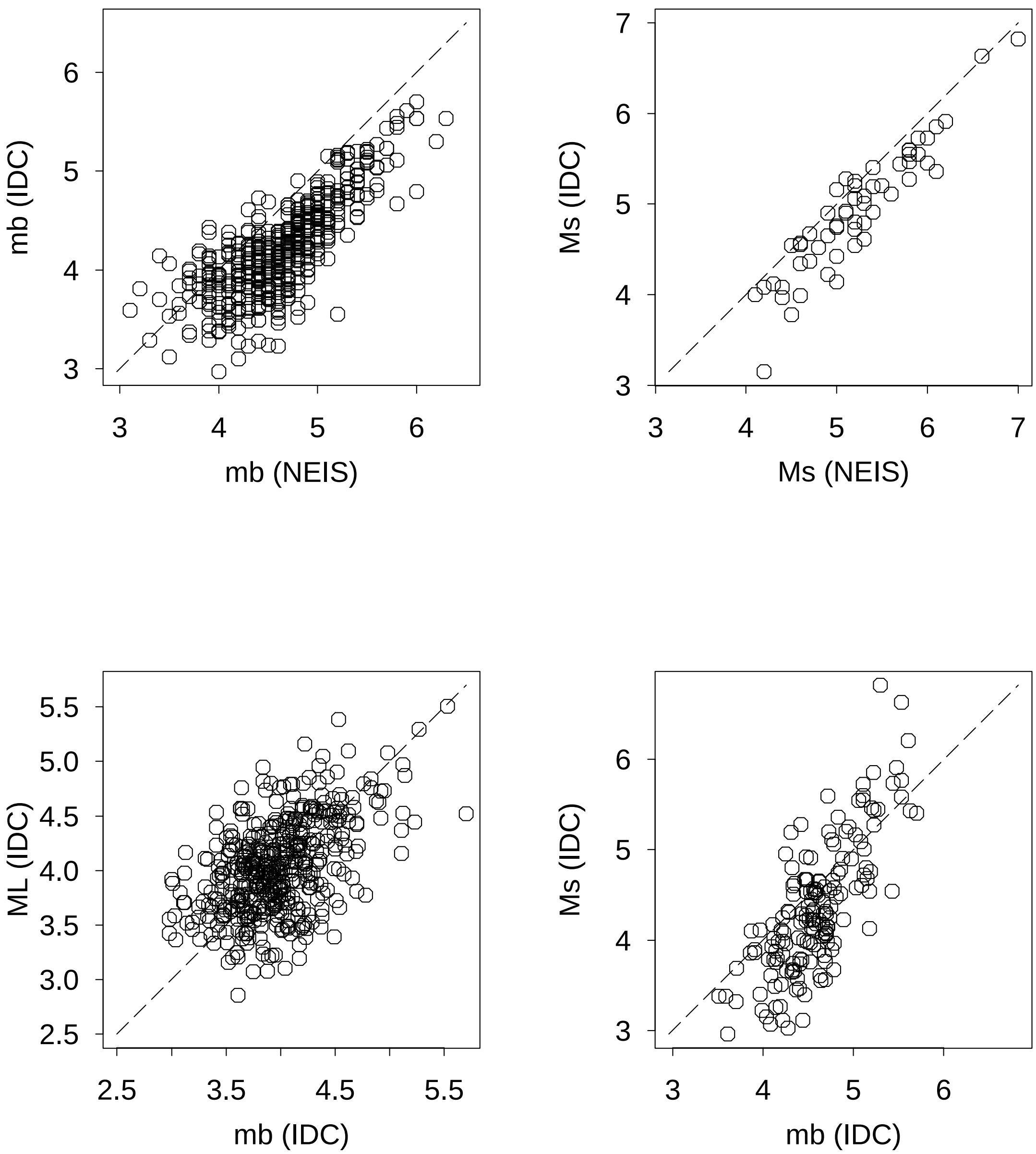


Figure 27. Comparisons of magnitudes from the REB with those for the same events in the QED (top) and REB comparisons of m_b with ML and Ms (bottom).

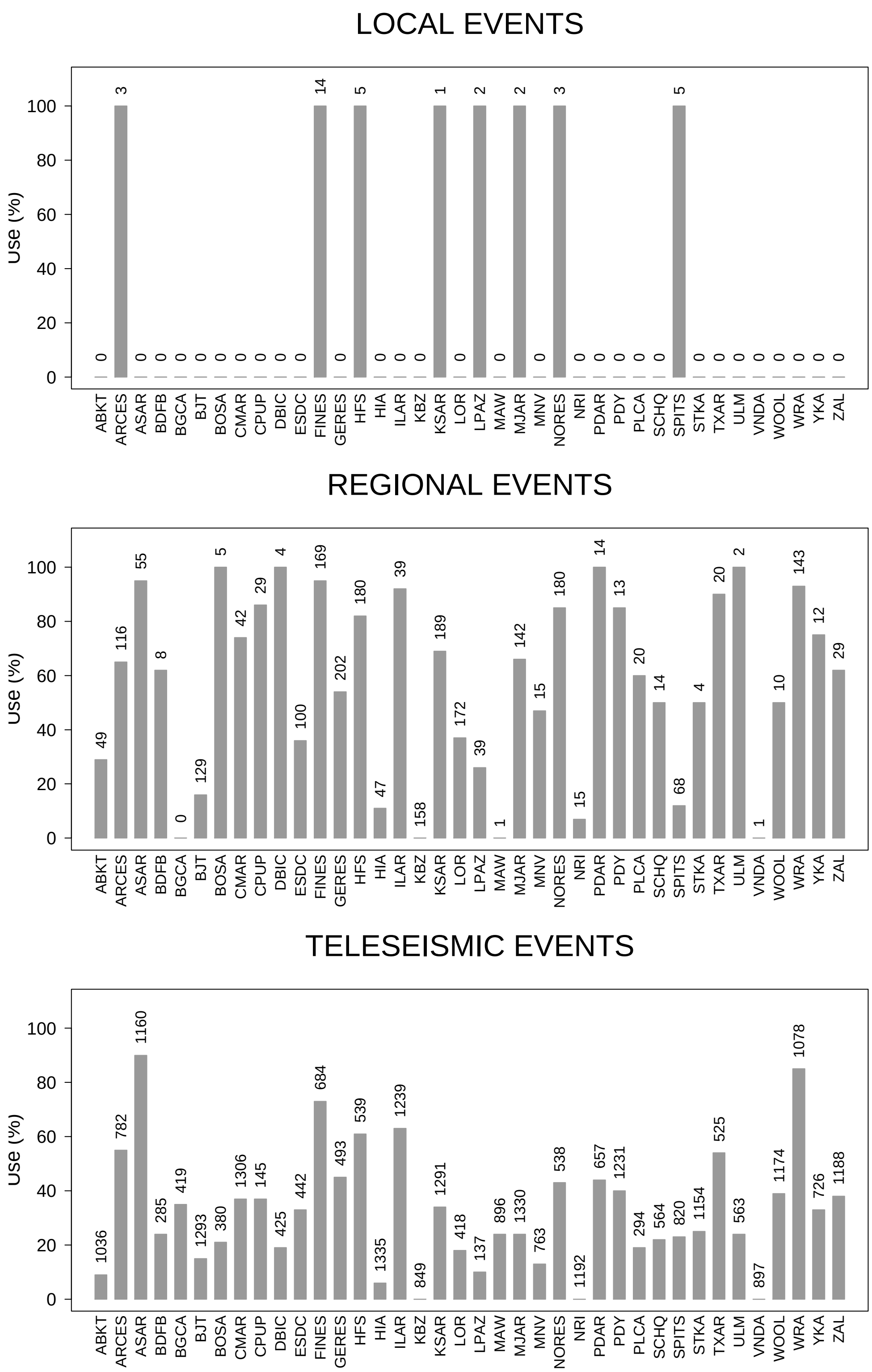


Figure 28. Use of primary stations in the REB for events at local ($0-2^o$), regional ($2-20^o$), and teleseismic ($20-90^o$) distances. The number above each bar represents the number of events within the specified distance range of the station, and the height of the bar is the percent of that number for which the station was used in the REB solutions.

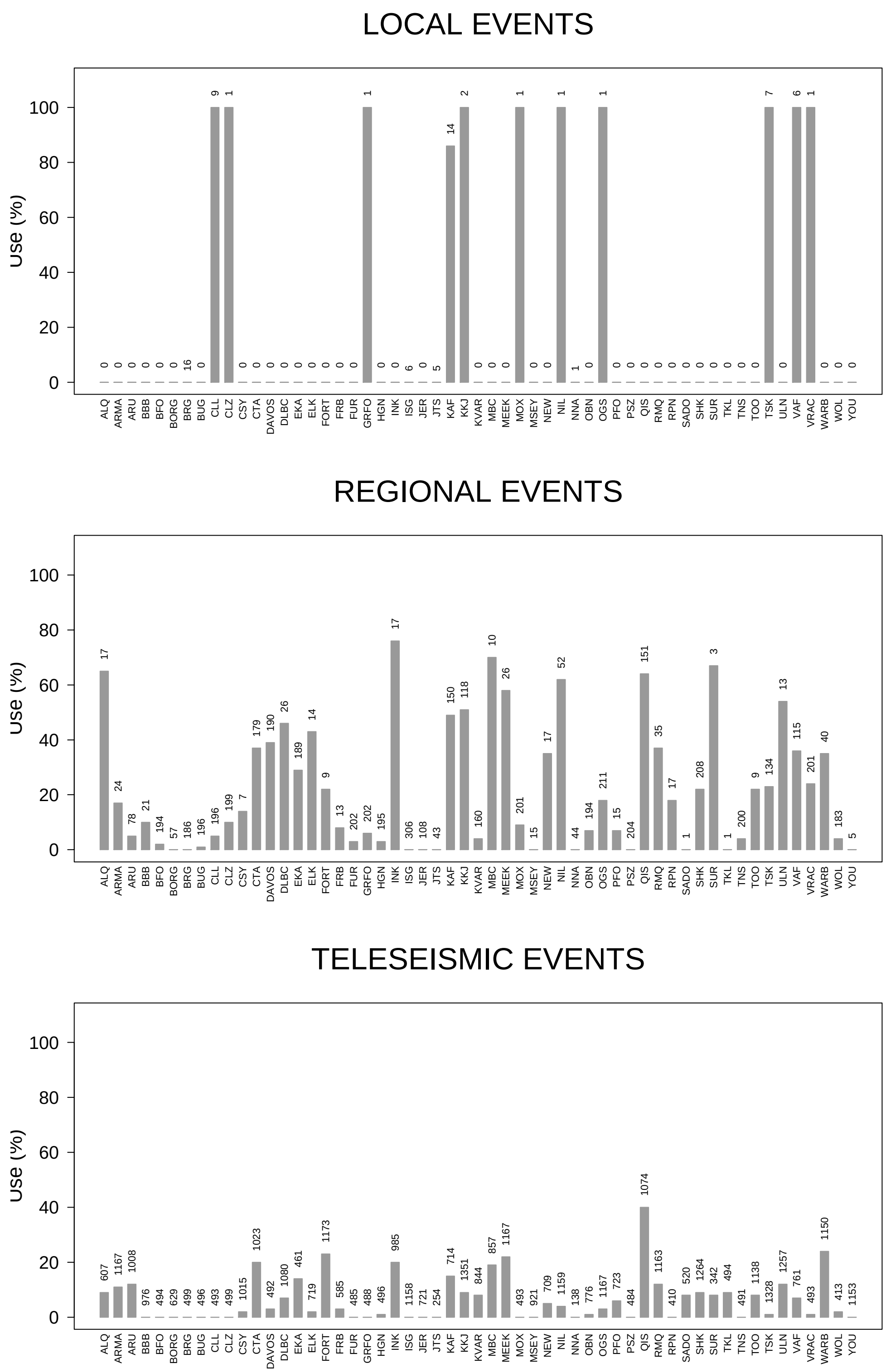


Figure 29. Use of auxiliary stations in the REB for events at various distance ranges. Telephone stations are not shown.

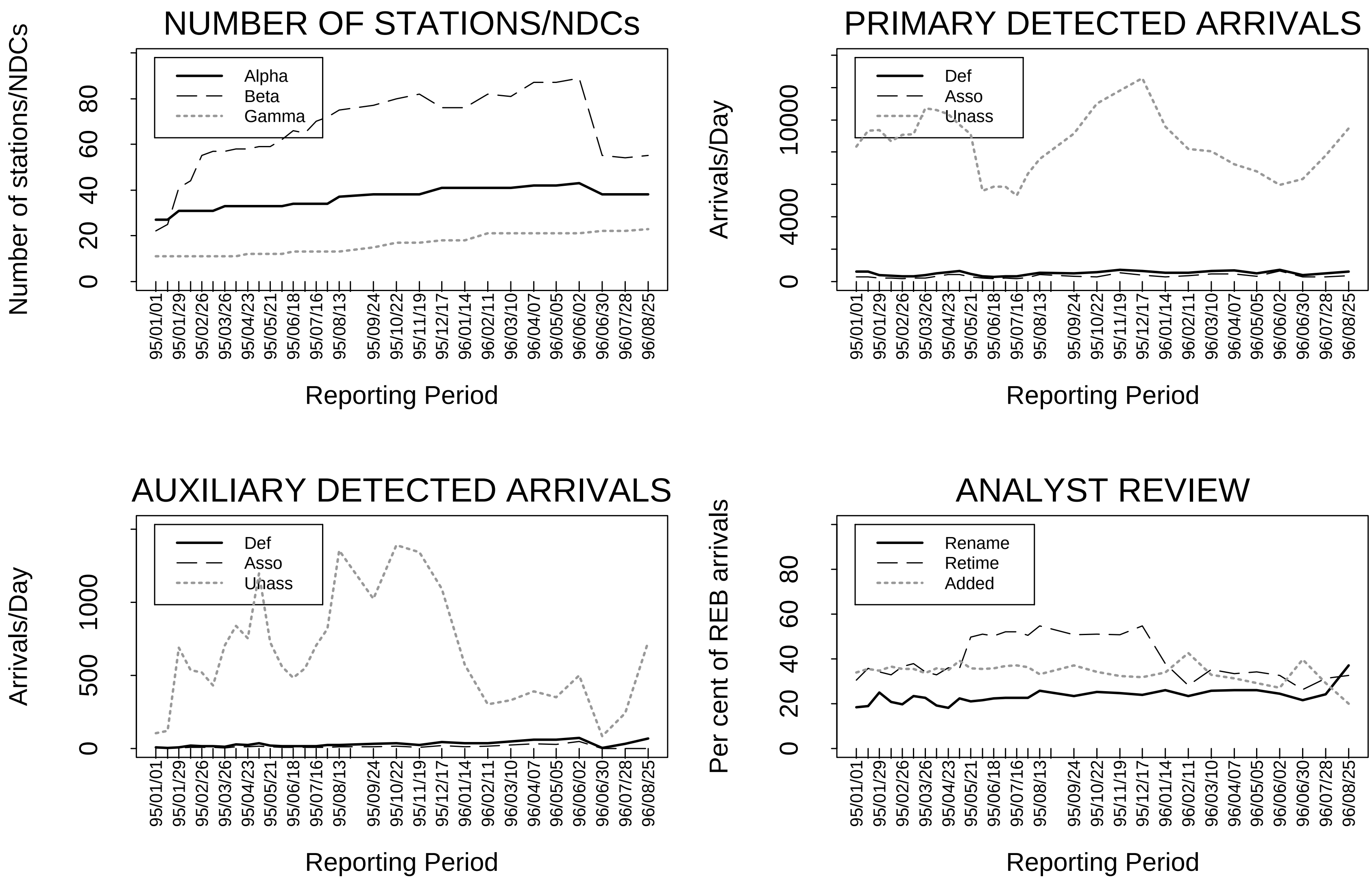


Figure 30. Performance of network and signal processing since the beginning of GSETT-3, Version 3. Dates shown are the beginnings of the report periods represented by the data points. Phase detections are from the DEL.

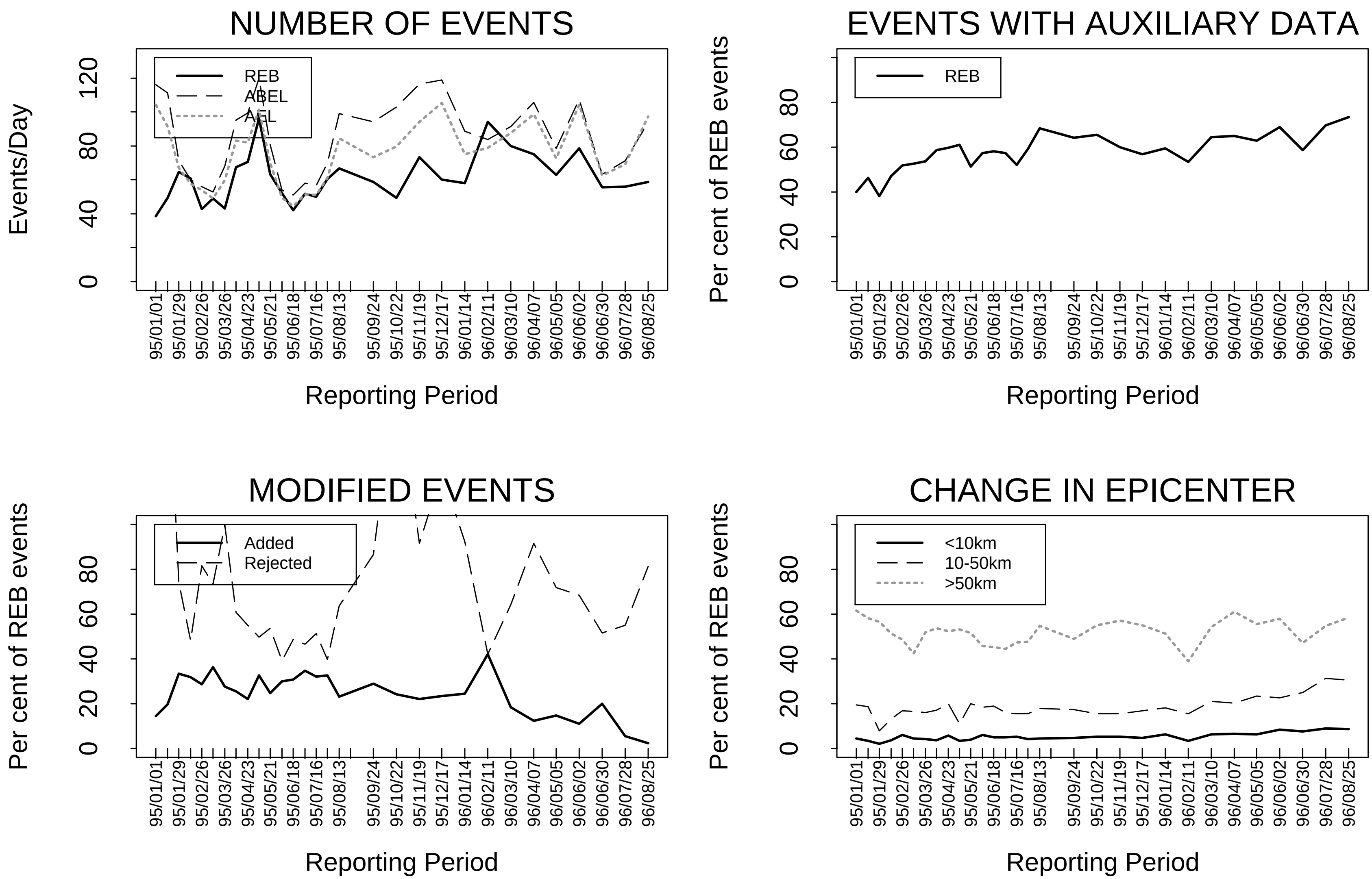


Figure 31. Performance of event processing, since the beginning of GSETT-3, Version 3. Dates shown are the beginnings of the report periods represented by the data points.